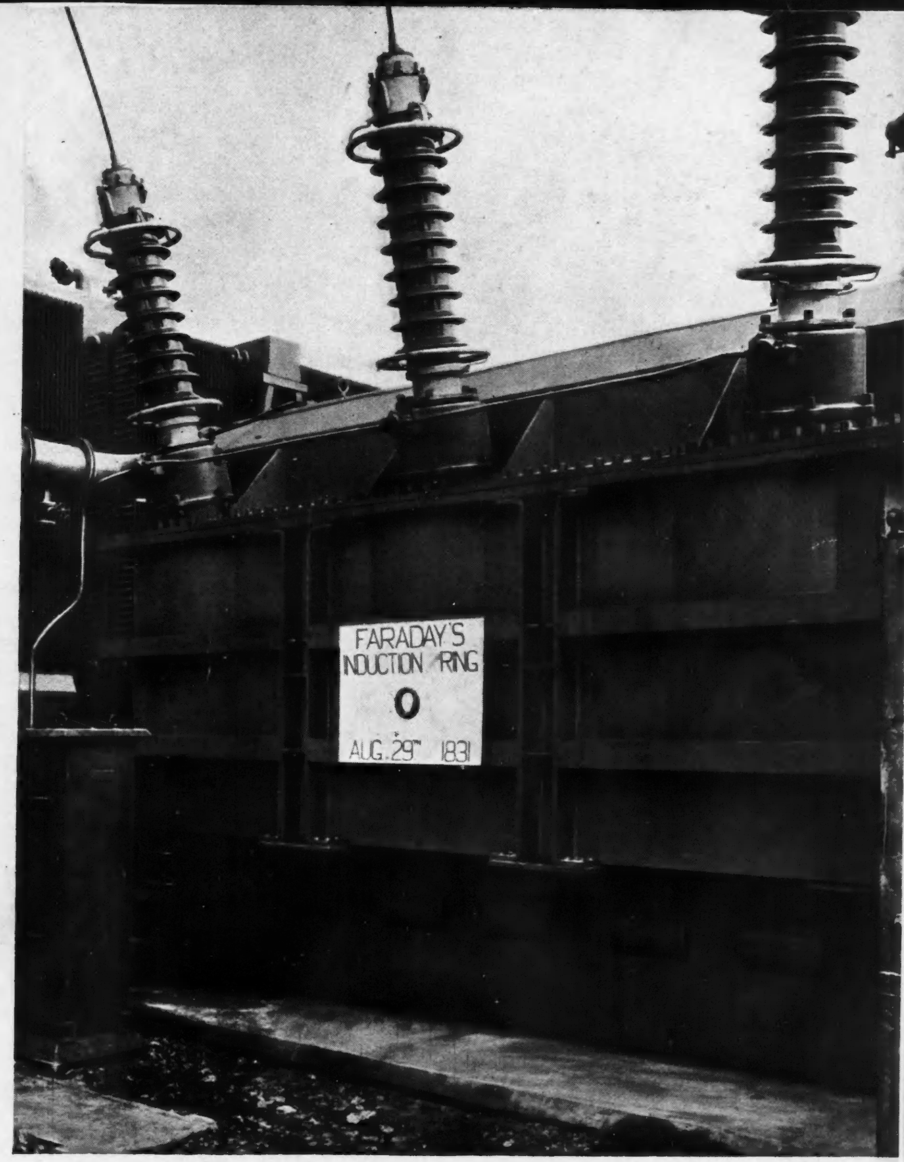
DISCOVERY



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DISCOVERY

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The Progress of Science

A MONTHLY NOTEBOOK COMPILED UNDER THE DIRECTION OF DAVID S. EVANS

The Missing Technician

BEFORE the war many domestic articles were, as someone said of the British Press, twopence plain and a penny coloured. At first sight the only difference between low-priced and expensive articles of the same kind was that the cheaper one had been embellished with a hideous little ornament, a revolting pattern, or a miscellaneous collection of knobs and bumps, birds or beasts. Very often of course the knobs and bumps were only put on to hide some defect. A plain simple object whose beauty lies in its satisfying shape can only be made out of first-class material. A beautiful smooth finish all too often shows up defects which otherwise would be hidden.

However, a great deal of trumpery ornament was applied in an attempt to make an inferior article look good, or because the manufacturer was devoid of taste or was meeting a demand from people who liked that kind of thing. Quite apart from abstract aesthetic considerations many types of ornament positively detracted from the usefulness of the objects which they adorned or rendered them impossible to clean properly.

An important advance which we have seen during the war is the introduction of utility furniture, clothes and other goods. They are intended to economise labour and material and at the same time to protect the public against racketeering in inferior quality articles. Very many of them represent a real advance on pre-war conditions in many ways. Obviously they are less heavily built and less robust than one would like them to be, but the public realising that material must be stretched out as far as possible, accepts them as an honest-to-goodness attempt to produce as sound and as cheap an article as possible under difficult circumstances. Their designs are good. The quality of workmanship varies somewhat from factory to factory, but with all makers working on more or less equal terms there is likely to be some rivalry as to who can do best at the job. Most important of all is that something of a precedent has been set: some sort of standard as to what is a good piece of furniture and what is not: it is the standard of a piece of furniture, well made, fitted for its purpose and good looking as well. Fitness for purpose alone is not enough—for many utilitarian articles can be supremely ugly—but it is an ingredient which is essential.

These reflections have been prompted by the reading of a book by Mr. John Gloag entitled *The Missing Technician*. The missing man, in Mr. Gloag's view, is the industrial designer. His job is to design, in collaboration with the manufacturer's technical experts, articles for domestic and other uses, which not only do their job properly, and are made from materials used in accordance with their own special properties, but which are pleasing to use and see. His book is studded with interesting examples—the saucepan that will really pour properly, the electric iron that deals gently with buttons and has no nasty projections to tear the hands and fray the temper, the things made out of plastics which are not got up to look as if they were wooden; even the streamlined locomotive—which is graceful because it is efficient. The electric iron is discussed in detail. The design was produced by the manufacturer's technicians in collaboration with the consultant designers. The result was tested by the housewives who would have to use it and the final product is calculated to please everybody. One point was not mentioned however. The writer has never had to replace a heating element on this type of iron, but anyone who has ever tried it with an old-fashioned model will know that they were all constructed with the express purpose of making it as difficult as possible to get the components back together again. It is to be expected that so distinguished a collaboration would not have overlooked such an elementary point.

The technique advocated by Mr. Gloag, and one which he has seen in action, is to set up a working committee including both the technicians employed by the firm and the outside consultants. Mr. Gloag looks at the matter from the point of view of the advertising agent concerned to see manufactures flourish under the present economic system. Many scientists will not be particularly sympathetic to this point of view, but few of them will deny that the results are worth taking seriously. Imagine what might have been the consequences fifty years ago of calling

in a distinguished architect to design the Victorian equivalent of a telephone kiosk or radio cabinet. Both these things have happened and the outcome shows that it was worth doing and a task not unworthy of the skill and talents of the great man.

One is often too close to the march of events to see the really significant things when they happen. Almost under our noses during the last decade, operational research on ordinary every-day articles has been developed. An important change has taken place almost unrealised by the general public. After the war there will be a great many young men who have learned a lot about military operational research, and who might find their knowledge and experience could be invaluable in industrial design. Mr. Gloag is especially complimentary to the architects who, he says, combine a wide knowledge of materials with vision and imagination. He has rather little to say about the scientists and technicians who are concerned, and this is perhaps correct, since scientists are often rather prone to make things in ways which would be good enough for the laboratory but lack beauty and simplicity of use in inexpert hands. But now many scientists have added a new sort of experience to their purely technical repertoire and may be regarded as properly qualified to step outside their original bounds. It is to be hoped that after the war there will continue to be series of articles available which are deliberately designed for their purpose and which will set standards of value, quality and beauty at not too high a price. In a word Utility should continue, not as a temporary expedient, but as a public example of what a good commodity ought to be. One personal hope is that this will help to sweep away those examples of bogus modernity which disfigured our markets before the war. Streamlining, for instance, as Mr. Gloag reminds us, is the shaping of a body so as to secure aerodynamic or hydrodynamic efficiency. It does *not* mean distorting domestic articles to look like racing cars and making them completely unusable. These and other instances of the conversion of genuine functional features of one type of article into the superfluous ornament of another could be given. Let us hope, however, that the future holds for us the promise of new and better manufactures, scientifically and genuinely designed for use and beauty.

The Last Hundred Thousandth

THE standard of length used to be the distance between two marks on a piece of metal kept in Paris. Now it is the wavelength of the red light in the spectrum of the metal cadmium. Throughout metrology there has been a steady turn over towards the use of optical standards because the accuracy of measurement which is attainable is of about the same order as the wavelength of light, that is of the order of one-hundred thousandth of an inch. Much of this work requires optical apparatus of the highest degree of excellence and very considerable cost, but there is at least one application where differences of dimensions of no more than one-hundred thousandth of an inch can be distinguished with the aid (in a traditional phrase) of no more than a candle and a table knife.

In the working of optical mirrors the shape and finish of the concave face is all important, for there will later be deposited on that face the minutely thin film of silver or

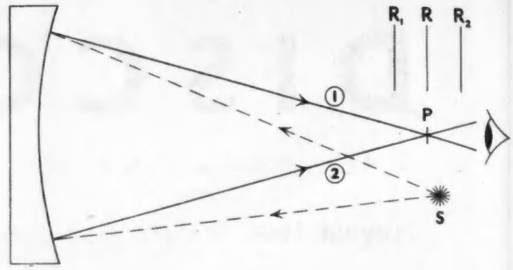
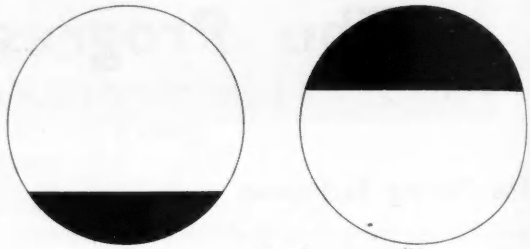


FIG. 1



(a) FIG. 2 (b)

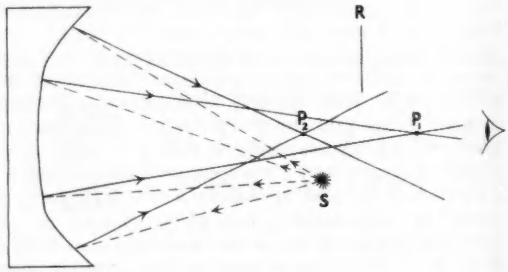


FIG. 3

aluminium which will reflect the light and bring it to an image which will be good or bad according as the shape of the surface is good or bad. In making a telescope mirror the concave face is first ground out with the aid of carborundum to a shape which is approximately that of a sphere. In the early stages coarse grades of abrasive are used which leave the glass surface pitted and presenting a "ground glass" appearance. Under the microscope these pits can be seen, but as the work proceeds finer and finer grades of abrasive are used, until the surface seems smooth but dull and the pits are extremely minute. The surface is then polished by working it on a layer of pitch using jeweller's rouge as an abrasive. When this process is complete the surface should be perfectly smooth and accurately spherical. The final stage consists in working down the edges more than the middle so as to produce, not a sphere, but a shape called a paraboloid which brings parallel rays falling on the mirror to an exact point focus. For a mirror six inches in diameter and with

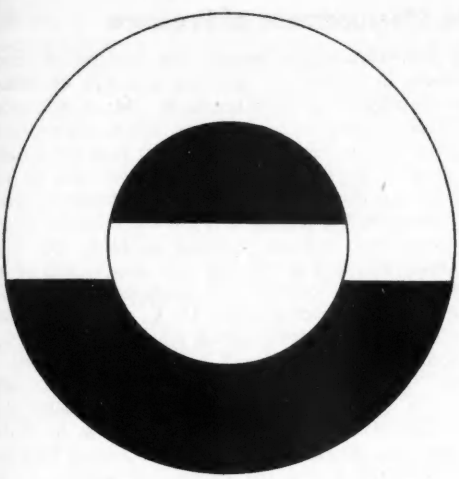


FIG. 4

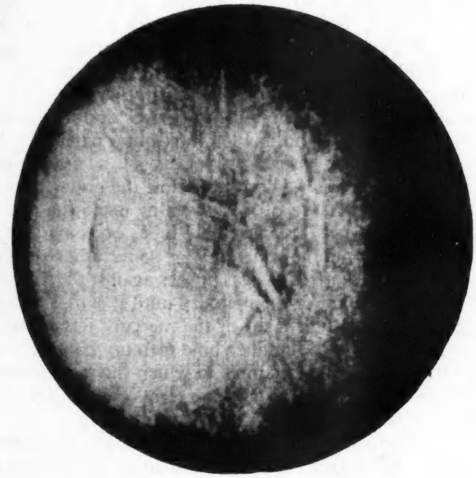


FIG. 5

a focal length of about four feet, the amount to be worked away in this last process is only just over one-hundred thousandth part of an inch. To test the original spherical shape and to provide a means for determining when the correct amount has been worked off the edges so as to produce the paraboloid the table knife and candle (or their more modern variant, the razor blade and torch bulb) must be called into play.

This particular test, known by the name of the French mathematician and physicist Foucault (1819 to 1868), is simple enough to set up, but in the hands of an expert can be an instrument of wonderful power and delicacy. The method can be understood by reference to the figures. The first shows a perfectly spherical mirror illuminated by a point source of lights which is placed very near to the centre of the sphere. All the rays coming from the source are then reflected back almost exactly along their original paths and return to a point P very near to the source. An observer placing his eye just behind P will see rays coming from all over the mirror, which will appear to him as an illuminated circle. If he then brings in the razor blade R edgewise so as to cut off the rays exactly at P, they will all be cut off at the same instant, and the mirror will go dark all over instantaneously. If he brings the blade in at R, he will cut off the ray marked 1 before the ray marked 2. The ray 1 falls on the lower part of his eye, so that as the blade moves in at R, the observer sees a shadow moving *upwards* across the mirror as in Fig. 2, a. If on the other hand the blade is brought in at R_2 (nearer to the eye than P), it is ray 1 which is cut off first, and the observer sees a shadow moving *downwards* across the mirror as the blade is brought in (Fig. 2, b).

Thus if the blade is brought in nearer than the point of convergence of the rays, the illuminated disc goes black from the top down: if the blade is brought in further away than the point of convergence, the blackening is from the bottom upwards.

All this is for a perfectly spherical mirror which returns all the rays to a single point; but as everybody who has ever had anything to do with mirrors knows, real mirrors are never perfect.

Now consider what happens with an appallingly bad mirror like the one in Fig. 3, in which the surface is not spherical and the edge is turned up all round. The rays from the source S which fall on the centre of the mirror will be thrown back to a point P_1, but the rays which fall on the turned up edge will be much more convergent, and they will all converge at a point P_2. If now the observer brings in his razor blade at R, it is *beyond* P_1, the point of convergence of the rays from the centre of the mirror, so that part of the mirror will darken from the bottom *upwards*. But the blade comes in *nearer* than P_2, the point of convergence of the rays from the edge of the mirror, so that part will darken from the top *downwards*. The sort of thing the observer will see is shown in Fig. 4. What one sees in fact is a very subtle pattern of shading following this general form, but with a trained eye it is quite possible to distinguish between a perfect sphere and a perfect paraboloid even when the difference is only one-hundred thousandth of an inch or so.

By this test all the faults of a mirror can be detected and eliminated, and its whole life history can be seen written on its face. The photograph (Fig. 5) shows a mirror which had a dissipated youth, although the unaided eye could not detect it. The test tells all its sordid story in detail. The general pattern of shading can be seen which shows that it is not a perfect sphere, but there is plenty more besides that. The granular spots all over the surface show that in the early stages of grinding the maker was impatient and failed to remove all the pits produced by grinding. All that has been done is to polish off the tops of the bumps producing a series of flat plateaux above a lumpy plain. Then there is a number of scratches, none of them visible to the naked eye, but showing up like small mountains under test. All these defects which look so obvious now would be almost undetectable by any other means, but if the mirror were used for optical work it would be found to be unsatisfactory in various ways. The test shows why.

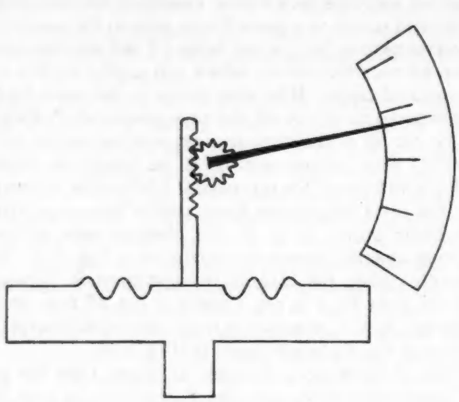
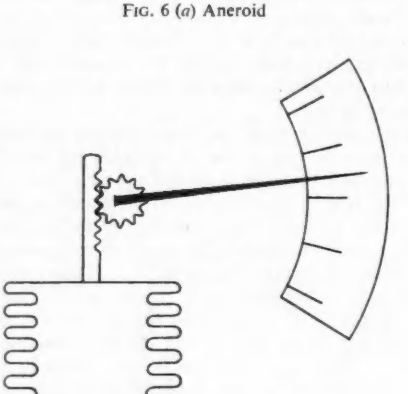
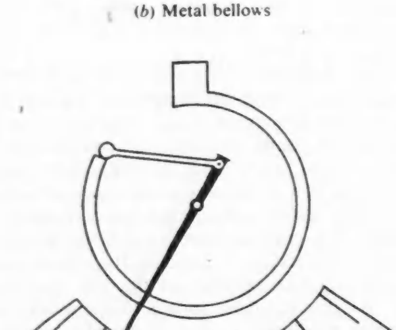


FIG. 6 (*a*) Aneroid



(*b*) Metal bellows



(*c*) Bourdon gauge

The Measurement of Pressure

THE inter-relationships between the progress of science, advances in technology, and the demands of industry form the subject of a fascinating study. Mr. A, an engineer, may feel the need for some device, which, when invented by him, fills the need in the particular field for which he designed it. Professor B, a physicist, working on some abstract investigation of pure science happens to hear of this invention and realises it is just the thing he needs to get over some difficult technical problem. By its aid Professor B's work is crowned with success and he finds a new scientific principle of fundamental importance which is further investigated by Dr. C, and made the basis of a new technical device which may even be the answer to some new problem which has turned up in Mr. A's work. Sometimes the track starts in pure science, sometimes in technology, sometimes in the demand of the chairman of a company for a new process to beat his competitors. Once started, the track zigzags backwards and forwards across the domain of science, perhaps touching only one discipline, perhaps visiting all the sciences from geology to medicine.

One particularly striking instance has recently been given by Dr. L. B. Hunt, who has given a sketch of the history of pressure measurement. This particular track had several beginnings and the various initiators spent a considerable proportion of their time in litigation about it. One of them was Lucien Vidie, a lawyer and a scientific amateur of Nantes, who in 1844 took out a patent for the measurement of pressure by means of a closed and evacuated metal vessel. Until that time the only means of measuring the pressure of a gas was by enclosing it in a vessel to which was attached a U-tube, or some similar arrangement, containing mercury or some other suitable liquid. The pressure of the gas pushes against the mercury and raises a column of the mercury until it stands at such an elevation that the weight of the mercury just balances the gas pressure. The cumbersome mercury barometer is, of course, the obvious example in which the measurement of the pressure of the air is given in terms of the height of a column of mercury which it would just balance.

Now in principle any quantity which could be made to vary in a thoroughly reproducible manner in response to changes in pressure could be used as a pressure gauge or manometer. The size of a rubber balloon for example depends among other things on the excess of the pressure inside over that outside. If one were fully conversant with the behaviour of any particular balloon the measurement of its extension could be used to measure the pressure of the gas which it contained.

What Vidie did was in effect to construct a metal balloon, a thin flat metal box with semi-flexible corrugated faces, which were distorted to a greater or a less degree according to the pressure of the gas within the box. The measurement of the degree of distortion was effected by a mechanism which turned a pointer on a scale. Once the properties of each particular metal box were known, it was unnecessary to think of measuring the distortion in inches or centimetres; the scale could be marked off in pressures directly.

Whatever Vidie's motives for undertaking this work, it was an immediate commercial success. Not only did he

invent the form of manometer in which the pressure responsive element is a flat box, but he also devised a form in which the pressure was measured by the extent to which it was capable of extending a flexible metal bellows.

The motives of another inventor of almost the same period were quite clear. Louis Andrée of Magdeburg wanted to produce a pressure gauge for measuring the pressures in the boilers of railway locomotives, a purpose for which Vidie himself sold many of his gauges. Andrée used a sort of metal concertina arrangement consisting of five pairs of metal diaphragms by which a pressure up to six atmospheres (90 lb. per square inch) could be measured, and obtained a Bavarian patent for it in 1849. Perhaps it was the same interest in railway engineering which stimulated other inventors, for at about the same time patents were filed by two other inventors from Magdeburg and for a rather different type of gauge by a railway engineer named Schinz, a watchmaker from Coblenz and the Frenchman, Bourdon.

This last type of gauge is now known by Bourdon's name and consists of a tube of oval cross-section sealed off at one end and bent into an almost complete circle. When the pressure is admitted to this bent tube the metal stretches slightly and the circle increases a little in radius. If the sealed off end is left free to move, the amount of movement measures the pressure and can be read off on a scale by means of a pointer connected to the sealed end.

For a time Vidie and Bourdon were business partners, but the association broke up and there was a series of legal actions in which Vidie sued Bourdon for infringement and eventually won his case. As Dr. Hunt remarks, to-day the judgment, by which Bourdon paid 25,000 francs damages and surrendered all the instruments manufactured, seems very harsh in view of the very real innovation represented by the Bourdon form of gauge.

Readers may be puzzled to know where they may have met pressure gauges of one or other of these types, but a little investigation shows that they are as familiar as prose to the bourgeois gentilhomme. The hall barometer (which must be very gently tapped to get an exact reading) is probably an aneroid. The pressure gauges on ships and locomotives may be of the Bourdon type. At the doctor's the blood pressure will be measured, perhaps with the mercury manometer, perhaps with an aneroid. Throughout industry men are reading pressures by means of these gauges; in the laboratory—and not only in the physical laboratory either—investigations are going forward in which these gauges are supplying essential information. They are helping to keep things moving now, and they are helping towards progress in the future, making possible advances in pure and applied science, blazing new trails which link together all the sciences, however unrelated they may seem.

The Uses of Seaweeds

To many people the word seaweed suggests little more than the memory of a seaside holiday. It is not generally known that the seaweeds are of considerable and increasing commercial importance. Botanically speaking they belong to the very large group of plants known as the algae. This group includes not only most of the marine plants, but also many of those which, as long green fronds, occur in fresh water. The life-histories of the majority of the seaweeds are still very imperfectly understood, but they are characterised in many cases by a remarkable "alternation of generations" in which reproduction is alternately sexual and asexual. Commercial demands and the possibility of cultivating the more valuable kinds in seaside "farms" has in recent years resulted in increasing attention being paid to the natural history of these primitive plants and their relationship to their environment.

Seaweeds are utilised in three main ways: in agriculture, in industry, and as food or medicine. In agriculture seaweeds are used both as manure and fodder and in many coastal regions are regularly harvested for these purposes. As a manure, for which driftweed is generally used, their value is twofold, as they provide both mineral salts and bulk for the soil. In the Orkneys it has been customary for very many years to allow sheep to graze on the rocks at low tide. In other parts of Scotland a kind of silage is prepared by storing seaweed and hay in alternate layers. When added to the daily diet in small amounts seaweed meal is said to increase the health and fertility of cattle and poultry.

Until quite recently seaweeds were the main source of the element iodine, and even to-day a small proportion is still obtained from this source. The bulk of iodine, is however, now obtained as a by-product in the purification of caliche (sodium nitrate) obtained from Chile. In the older method of preparation brown seaweeds are dried and then burnt. The ash, known as kelp, is then extracted with water and the iodine removed in the form of a salt, potassium iodide. Before the war the world production of iodine was about 1,000 tons per annum, of which 99% was used in medicine. Kelp also contains considerable quantities of potash and is a valuable fertilizer.

Another very important substance obtained from seaweeds is algin or alginic acid. This is obtained by boiling freshly harvested brown seaweeds with soda solution. The tissues swell up and lose their shape and are then filtered through cloth. On acidification the algin separates as a thick, slimy substance. Algin has been shown to belong to the class of substances known as the polysaccharides, a class which includes starch and cellulose. If algin is treated with vulcanising agents such as carbon disulphide, it yields a rubberlike substance which has been put to a variety of uses. Among other things it has been used to make rollers for typewriters. On treatment with a mixture of strong caustic soda and tannin, algin yields a transparent substance, similar to cellophane, which is extensively used as a wrapping material. By yet another type of treatment algin can be converted into an excellent artificial silk. In this country algin is extracted from certain seaweeds found on the Atlantic coast of Scotland and is marketed in the form of a white powder known as "Manucol" (sodium alginate). Manucol is used in the manufacture of cosmetics, textiles, transparencies, and plastics. When added to dried milk, alginates prevent sedimentation on reconstitution, and cocoa can be made more soluble in the same way. Alginates are valuable emulsifying agents, and as such are used in the manufacture of polishing creams and even to prevent deposition of "fur" in boiler water.

Agar-agar is another valuable seaweed product. Before the war it was obtained solely from certain red seaweeds

[*Continued on p.* 251

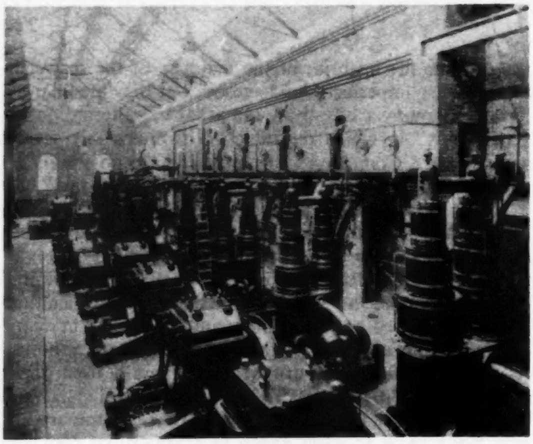


FIG. 1.—An early assembly of reciprocating engine driven generators.

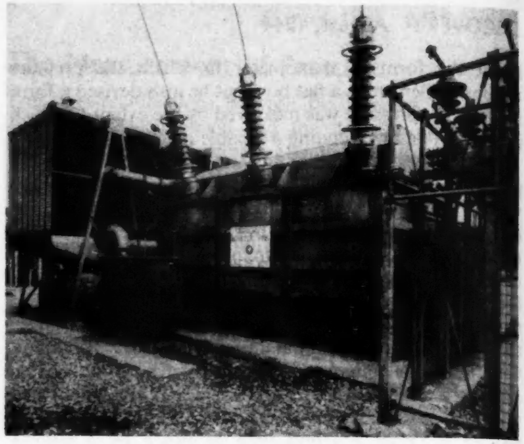


FIG. 2.—Showing progress from 1831 to 1931 in transformer design, with Faraday's original transformer of 1831 attached to a 60,000 Kilovolt-Amperes modern transformer.

The Electricity Supply Industry

JOHN A. SUMNER, M.I.E.E., M.I.Mech.I.

DURING the last two centuries, man has entered upon the threshold of a new world. He has found a key with which he can, if he desires, unlock the gate to a larger and happier life. This key is the use of power in the form of steam and electricity. In 1764 an ingenious mathematical instrument maker, James Watt, received a model of Newcomen's non-condensing steam pumping engine to repair. In 1769, when this left his hands, he had invented the condenser, thus transforming Newcomen's simple, inefficient engine into a power which was to lay a sure foundation for those future developments of electrical and mechanical power destined to effect a revolution in society. In 1820, André Ampère established that a current of electricity flowing in a conductor could produce a magnetic field, and the next step had been reached. It seems strange that it was left to Faraday in 1831, and not to Ampère, to discover the reverse of Ampère's magnet experiments—the ultimate step in the drama of progress—the fact that magnetism could produce electricity.

It is only 113 years ago that the first magneto-electric current was deliberately and successfully obtained by mechanical means. On September 23rd, 1831, Michael Faraday wrote to a friend saying, "I am just busy again on electro-magnetics, and I think that I have got hold of a good thing, but can't say. It may be a weed instead of a fish that, after all my labours, I may at last pull up." Within nine more days he had completed the whole series of experiments on electro-magnetism and had established the simple fact that the flow of current produced in a wire by the approach of a magnet was momentary and was followed by a second momentary flow in the opposite direction when the magnet was removed. From these fundamental discoveries of 1831, has arisen the present vast electrical industry and its huge generators, motors and transformers. The modern electric power station of 300,000 horse-power consists essentially of large machines for producing relative motion between a magnet and a wire, such as Faraday's simple apparatus achieved for the first time. Faraday's discovery gave us the elementary "magneto-electric" machine or dynamo, but it was not until 30 years later that the dynamo, using electro-magnets in place of Faraday's permanent magnets, was brought into practical use. Thus, it was not until 1866 to 1871 that electricity came into public use, and then only on a small scale, for lighting by means of the arc lamp. The first electric arc lamp seen in London streets was placed outside the Gaiety Theatre in 1878.

The electricity supply industry grew slowly. From the commencement of electric lighting in the 1870's, the next milestone came with the gradual development of the direct current electric motor which made possible a development of electric power supply. Then in 1891 came a clash of expert views. A young man named Ferranti insisted that the growing policy of installing small local generating stations, using direct current, was wrong. He advocated that the generation of electricity should be concentrated in a relatively few large generating stations situated outside the great cities and supplying through high-voltage transmission. This involved using alternating current so as to transform the generated voltage, firstly to the high transmission voltage and then down to the lower voltage for the consumer. What has been called "the battle of the systems" began—a battle of which the echoes still roll and during which the electricity supply industry grew to its

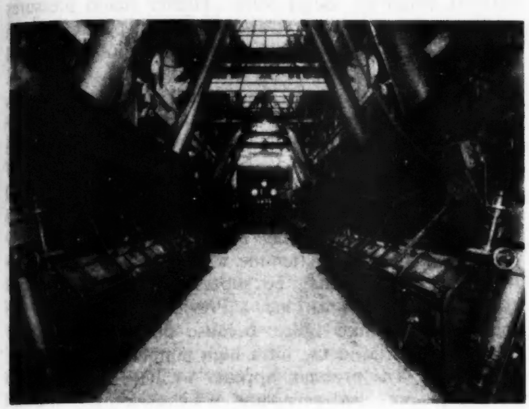


FIG. 3.—The boiler house of a modern power station.

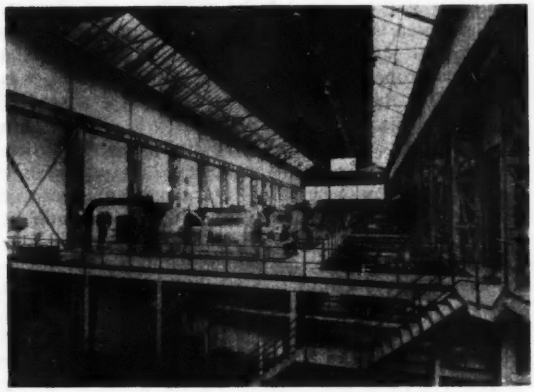


FIG. 4.—The Turbine room of a modern power station.

present gigantic stature. Unfortunately, it was not until the 1926 Electricity Act was passed, which gave us the Central Electricity Board, that Ferranti's policy advocated nearly 40 years earlier was adopted.

In considering the general reference to the "generation" of electricity, it is perhaps more correct to consider the process as a transformation of energy. The chief material needs of the modern world are light, heat and power, all of which are forms of energy derived originally from the sun. Coal represents the chief repository of this stored energy which is available in Great Britain. In the production of coal, the energy of heat and light from the sun was converted by chemical means into vegetable life and stored in the tree, which ultimately was changed to carbon in the form of coal. When coal is burned in a steam-electric generating station, the carbon unites with oxygen, so as to produce a chemical reaction which liberates the heat energy. Steam is used as the medium to convey the heat energy to the turbine, where it is converted into the mechanical energy of rotation. The final transformation of energy takes place in the electrical generator, where the mechanical energy is converted into electrical energy, available for subsequent re-conversion into the energy of light, heat or power.

A more simple case of this transformation of energy occurs in the hydro-electric power station. In this case the energy is stored in a large body of water which is at a high level. This potential energy is then transformed into kinetic energy, i.e. energy of motion when the water is allowed to fall on to the blades of the water turbine, and so results in mechanical and finally electrical energy. Electricity may therefore be looked upon as a convenient means of conveying energy over a distance to a given point, at which it can be used in another form, e.g. as heat or light when the electric current passes through a resistance wire, which then becomes heated, or as power when it causes an electric motor to revolve.

Statutory Development

The first Electricity Acts, known as "Electric Lighting Acts", were framed between 1882 and 1888, at a time when electricity was used principally for lighting and its application to power purposes was almost unknown. The effect of this legislation was to "parochialise" electricity supply and to place it in the hands of a large number of undertakings, each operating over a small area which was generally settled by geographical and (often) political considerations. Each town wanted its own "Electric Lighting Works" and each obtained a separate Act or Special Order, limited to the local authority boundary, as regards area, and granting a monopoly to supply within that area. (Generally, the municipal authority was given power to take over the undertaking, if it was operated by a company, within a specified number of years.) Naturally, this uncertainty restricted development, and it was not until 1919 that any real step was taken by Parliament to reverse this trend of the multiplicity of small undertakings, by which time there were over 650 separate statutory undertakings and probably another 300 or more non-statutory undertakings. Thus Parliament faced a Herculean task in reducing the number of undertakings and thereby reasonably standardising the conditions of supply.

The 1919 Electricity Bill proposed to remedy the matter by compulsorily dividing the country into a score or more districts, each administered by a Joint Electricity Authority, and thus drastically to reduce the number of undertakings. Through action in the Upper House the Bill was altered, and the compulsory provisions were deleted. As a result, only three Joint Electricity Authorities were formed, and over 600 separate undertakings remained. In 1926 an Act was passed which gave us the Central Electricity Board and the "Grid". The duty imposed upon this Board was that of connecting together, by means of grid transmission lines, all the efficient power stations and statutorily to direct the operation of those "selected" stations so that electricity was generated in a manner and at times which were in the national, rather than the local interest. Further, whereas each power station required nearly 100% more generating and boiler plant than was actually required for its own maximum or peak load so as to meet the possibility of breakdowns or overhauls, the proportion of this wasteful spare plant could be consider-

ably reduced, or even eliminated, when interconnection with other stations, through the grid lines, was effected. It is estimated that in less than ten years up to 1936 the total capital saving arising from this reduction in the necessary proportion of reserve generating plant was £14,000,000; this saving was achieved by the advent of the Central Electricity Board and its grid transmission lines interconnecting the cities and power stations. Further very substantial economies were achieved by running only the more efficient generators. During the one year of 1936 the saving effected in this manner was estimated at £1,000,000.

Immense strides have been made within the electricity supply industry itself to remedy the chaotic medley of voltages, frequencies, tariffs and charges which arose during the earlier years of intense individualism, fostered to a great extent by early legislation. The 1926 Electricity Act was the first great experimental step in statutorily destroying the parochialism to which electricity supply seemed to have been fated. The scheme propounded by Dr. Ferranti a generation earlier had at last matured. Parliament will shortly be deciding whether to make a logical continuation of this experiment so as to ensure that electricity distribution, as well as generation, shall be formed into units large enough to take advantage of modern technical and administrative experience.

Development of Generating Stations

The epic of electric power station development commences at the end of the last century, when it was considered that the maximum size of dynamo suitable for manufacture was about 100 kilowatts, or 135 horse-power (1 kilowatt = $1\frac{1}{3}$ horse-power), and when Edison outlined the power station of the future as having row upon row of 100 kilowatt dynamos, each driven by a belt from a reciprocating steam engine. At a later stage of development the reciprocating engine and direct current dynamo reached their practical limit of size at about 10,000 h.p., and engineers were seriously considering how they could increase the output of these machines, already of huge dimensions, at a reasonable cost. The steam turbine supplied the answer by providing greatly increased power in much less space and with smoother running. In 1890 two 75 kW Parsons' turbo-generators were installed in the Forth Banks Power Station at Newcastle and in 1904 a Parsons' steam turbo-generator of 3,000 horse-power was being used. To-day both turbines and generators (supplying alternating current) have been so improved in design that a single turbo-generator of 100,000 horse-power is not unusual. The limit in size of a modern turbo-generator unit is one of economics rather than of design, and depends upon finding a suitable site at which coal and water may be economically obtained. Modern steam pressures have risen from 100 lb. per square inch at the beginning of the century to 1,300 lb. at the present time. This tendency of increasing steam pressures is allied to the increase in steam temperatures approaching 1,000°F. and is inspired by the desire to reach higher thermal efficiencies. When steam is used as the medium to transfer the heat energy in the coal to the turbine, the engineer must face the inevitable loss of approximately 60% of low-grade heat to the condenser cooling water without obtaining useful work. Higher steam pressures and temperatures at entry, and the lowest possible steam pressure at exit, have permitted him to obtain useful work from nearly 30% of the heat in the coal. The 24 lb. of coal burned to produce one electrical unit in 1888 has been reduced to about 1 lb. to-day, but unless the coal, or other fuel, can be burned directly in the engine, the engineer has inevitably to resign himself to losing 60% of the heat available from burning the coal. The Diesel engine promised to give higher efficiency by burning the fuel directly in the engine, but the promise failed for mechanical reasons. After the war it would appear that the steam turbine may be superseded by the internal combustion or gas turbine. Previous experiments on this promising line failed because of the inability of metals to withstand the ultra high temperatures that are generated. The problem appears to have been solved in the jet-propelled aeroplane which uses an internal combustion or gas turbine, and we may look forward to the electricity supply industry achieving a consumption considerably less than 1 lb. of coal per unit generated.

The North of Scotland Hydro-Electric Board set up by the Hydro-Electric Development (Scotland) Act, 1943, has recently published details of the construction of hydro-electric stations which may have a major influence on electricity generation, within the limits of the water-power available in Great Britain. The scheme, estimated to cost £4,600,000, comprises three projects—at Loch Sloy, Loch Morar and Loch Localsh. An article by Mr. Eric Saunders[1] sets out very clearly the enhanced chances of the economic development of hydro-electric stations, due chiefly to the serious rise in the cost of coal to electricity undertakings during the last 10 years. Taking into account the rise in the price of coal, he estimates that after the war the average (generating) costs of electricity in this country are likely to be 0·3*d.* to 0·4*d.* per unit in steam power stations against 0·18*d.* to 0·25*d.* per unit for hydro-electric stations. The scheme to exploit the water power in the River Shannon comprising hydro-electric generators of 135,000 kW. has been in use for a number of years as also have water-power schemes in Scotland.

Unfortunately, Britain's water power resources are relatively small and, even when fully developed, can supply only a limited proportion of its requirements of electricity. It is not likely, therefore, that the development of hydro-electric stations, even including the development of tidal resources, such as the proposed Severn Barrage Scheme, will dispense with the development of power stations employing the heat cycle.

Transmission and Distribution

Practically the whole of the electricity used by the electricity supply industry is generated in selected power stations, nominally owned by the undertakings, but operated as to the times and amounts of electricity generated under the direction of the Central Electricity Board. These stations generate electricity at voltages varying from 6,600 to 33,000. The stations are linked together by the grid transmission lines which form a "gridiron" of 132,000 volt lines over the country, and may

[1] In *The Economist*, 7 July, 1944.

be looked upon as a receiving network. All electricity generated in the selected power stations is purchased by the Board and passes into the receiving network of 132,000 volt lines. Such electricity as is required by the undertaking owning the power station is purchased back from the Board and is taken from the receiving network: it may be more or less in quantity at any moment than is being generated in the undertaking's power station. Generally, the Board operate on a base (or continuous) load those stations which are the most efficient, and run the less efficient stations only at those times when the load is greater than can be supplied from the base-load stations of higher efficiency. In this way, at times of light national load, an undertaking in the South of England may have its generating plant shut down and be receiving electricity which is being generated at a station in the North Country. The large open-air structures which may be observed near to large power stations and from which the grid lines radiate, act as switching points which permit the grid-iron of Board lines to be sectionalised and controlled.

Thus, the electricity undertaking purchases and receives the electricity which it requires from the Board at 132,000 volts at its own transforming, control and metering centre. From this point, feeders—generally at 33,000 volts—radiate through the undertaking's area. Usually a feeder, forming a ring, will join up the radial feeders, and the area of supply is then divided into sectors of high voltage feeders which can be controlled and fed independently. Sub-stations, into which these feeders are led, contain transformers which reduce the voltage, usually to a secondary distribution voltage of 11,000, and at this voltage distributors are led along the streets so as to form secondary networks feeding in to further transformer sub-stations where the voltage is again reduced so as to supply the low-pressure distributors from which services are tapped directly and run into the consumer's premises.

Electricity Costs and Charges

The cost of generating electricity depends upon two main factors—the fixed annual costs incurred in providing the generating station and the running cost, which is largely the cost of fuel. If we assume that a 100,000 kW. generating station costs £1,500,000 or £15 per kilowatt, it will be necessary to pay about 10% or £1·5 per kilowatt per year to meet the fixed costs of interest, depreciation, etc. One kilowatt of plant running continuously throughout the year (8,760 hours), would produce 8,760 kilowatt-hours or electrical units, and the cost per unit to meet the fixed charges would then be £1·5 ÷ 8,760, i.e., 0·041d. per unit. Unfortunately, demand falls away during the night and at certain parts of the day, and the load factor, or percentage of use of the plant, is not usually more than 25% of its full use, so that the fixed cost per unit rises to 0·164*d*. The cost of coal, assuming 1·2 lb. is used to generate one unit, may vary from 0·15*d*. to 0·3*d*. depending on the distance of the power station from the coalfield, giving a basic cost of generation varying from 0·3*d*. to 0·5*d*. per unit generated. It is then necessary to provide the mains, services, meters, transformers, etc., to transmit and distribute the electricity to the consumer. For an undertaking with 60,000 consumers, selling 100 million units per year, the cost of such mains, etc., may be £2,000,000 and the fixed annual charges on this sum about £125,000, or 0·3*d*. per unit sold. With other charges for management, maintenance, repairs, etc., we arrive at a basic averaged total cost of from 0·6*d*. to 1*d*. per unit for supply at the consumer's premises. The more usual method of charge with modern undertakings, however, is what is known as the "Norwich" charge. By this method, a sum per year (based on from 10% to 15% of the rateable value of the house) is made as a fixed charge, independently of the units consumed, and the secondary charge, or charge per unit, is approximated to the actual cost of generation. The consumer is then paying directly his quota of the fixed annual costs of transmission and distribution. In order to encourage consumers in normal times to use electricity at night and at times when the generators are not fully loaded, it is usual to make a specially low charge for such use, equal only to the cost per unit of the coal used for generation.

The cost of electricity in the future will be governed by two main factors—an increasing use spread out more evenly over the 24 hours, and secondly, the post-war cost of coal combined with increasing efficiency in generating. It has been mentioned that a 100% use of generating plant, instead of a 25% use, would decrease the cost of generation by 0·123*d*. per unit. The second factor of the increasing cost of coal is even more serious. In the case of one power station using 150,000 tons of coal per year, the delivery price per ton has increased by 30*s*. in little more than 10 years, representing an increase of £225,000 per year, or about 100% on the total cost of generation. The effect of the national increase in coal prices has already been to stimulate the utmost development of our national water power, as it is estimated that hydro-electric schemes can now generate at about 60% of the cost in steam stations.

Electricity and the Nation's Coal Supply

Power constitutes the lifeblood of industry, including the agricultural industry, in the present century. For good or ill, steam power made possible the immense industrial production which the modern world demands, so that one man to-day has an output more than a thousand times greater than a man of the eighteenth century. Everything was sacrificed to the production of steam power, particularly our readily worked coal deposits, with results which are only now being appreciated. Unless we are prepared to drive our factories, to light and heat our rooms and cook our food in a more efficient manner than in the past, the wasteful use of the easily available coal reserves of this country must go on, but only for a relatively short time.

The electricity supply industry can claim to have made a unique contribution towards the conservation of our national coal resources. This claim rests upon two factors:

1. A continuous increase in the efficiency of the use of coal.
2. The use of inferior classes of coal which would otherwise have been wasted.

In 1888 Colonel Crompton investigated the coal consumption in 20 power stations. He found that they were

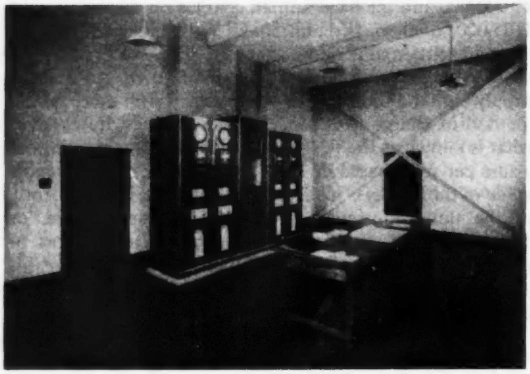


FIG. 5.—The nerve centre of a modern boiler house showing the automatic control panel.

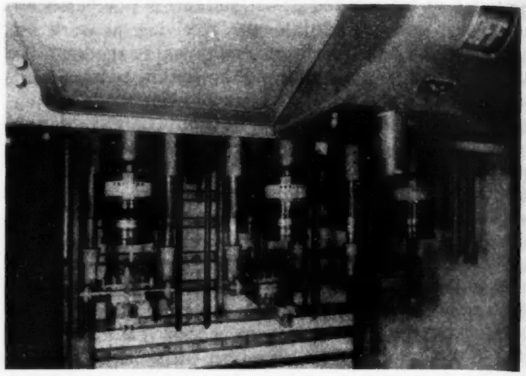


FIG. 6.—Interior of a modern high rupturing capacity switch.

using best steam coal and that 24 lb. of coal was consumed to produce one electrical unit (or kilowatt-hour). To-day, the consumption of coal per unit generated is less than 1¼ lb., despite the fact that this coal consists of 74% slacks and "smalls". The carbon filament lamp of 1880 using 4 watts per candle-power was replaced by the gas-filled filament lamp of 1920 using half a watt per candle-power and then by the filamentless lamp with a consumption of only one-third of a watt per candle-power. From 24 lb. of coal to 1·2 lb. per unit generated and 4 watts to one-third of a watt per candle-power represents a reduction of coal requirements by 240 times in a space of 60 years; an achievement of which any industry may be proud.

It is interesting to examine the type of coal used by the electricity supply industry. Many years ago electricity supply engineers began to design special boilers and grates which would be capable of burning the low grade small coal and slack for which the collieries had no appreciable market. This small coal slack was an essential result of working at the coal face and for many years there was no demand for much of the slack which had to be brought up from the mines and disposed of. The market which the electricity supply industry offered was taken up to such an extent that, in 1943, out of 23,000,000 tons of fuel burned by electricity power stations, approximately 20,000,000 tons was of a size varying from $\frac{1}{16}$ in. to $\frac{1}{2}$ in. An interesting example of this use of a wasted by-product occurred when a large power station was erected in South Wales in 1934, immediately adjacent to what was literally a "mountain" or dump of low grade coal, thrown out by a colliery as waste over many years and left to disfigure the landscape; the power station was constructed specifically to burn this waste material. It was not conceived to be possible that such material could ever be used; yet, for the last 10 years, the power station has generated more than 3,000 million units at the highest efficiency exclusively by using more than one million tons of this waste and low grade fuel. Since the war began it would appear that many more of these pit-mounds are being removed and transported to electricity generating stations to be used as fuel, thereby changing certain of the collieries' liabilities into valuable assets. Thus, except for the initiative and enterprise shown by the electricity supply industry, a large proportion of the annual consumption of 23,000,000 tons of fuel used to-day for the generation of electricity, might have been wasted. This development of efficiency is far from being completed.

The position regarding coal supplies has been summed up recently by Dr. Cohoe, the retiring president of the Society of Chemical Industry, who stated that "We are beginning to worry, and properly so, about the fuel supply of the future. Petroleum supplies were approaching a critical condition: coal would not last much longer and then we should have to fall back on unnumbered cubic miles of oil shale." It is quite clear that the requirements of industry and the household for power, lighting and heating, will have to conform with a policy for the efficient use of coal. There are three main forms in which the energy latent in coal is required to be used—as power, lighting and heating respectively. For power and lighting purposes it is necessary first to convert the latent energy in the coal to either electricity or gas and for heating purposes the coal may be burned direct to produce the heat or it may be used as heat in the form of electricity or gas. The criterion which must in future govern the use of power, lighting and heating is that the method employed must be such as to extract and use the maximum amount of heat energy originally available in the coal. So far as power and lighting requirements are concerned it is shown by Sir Dugald Clerk and others in the report presented to the Institute of Gas Engineers[1] many years ago, that the balance of energy originally available in the coal, when used for power and lighting purposes, was greater when electricity was used than when gas was used and in recent years the balance has swung over even more in favour of electricity. The question as to the most efficient method for heating purposes has yet to be decided.

If we consider the case of room heating by hot water circulation, the available heating effect in therms per ton of coal used will be in the following ratios:—Coal: Gas: Electricity : : 150 : 100 : 50. With an efficient coal-fired boiler running at 55% efficiency, neither gas nor electricity (when the latter is used directly in contact with the water)

[1] *Low Temperature Carbonization*, Wellington & Cooper, 1924.

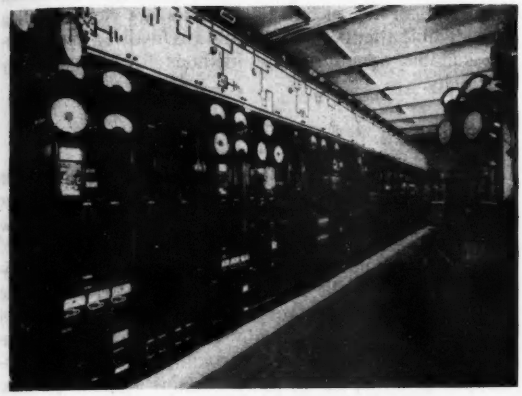


FIG. 7.—The nerve centre of a modern power house.

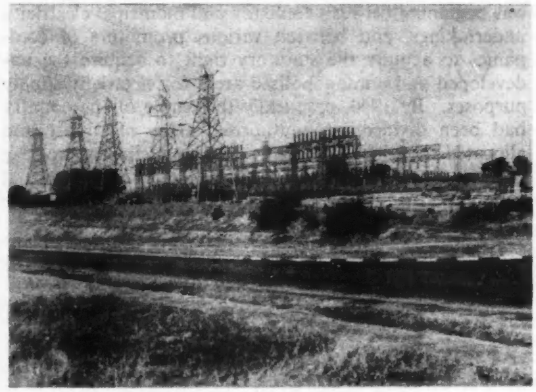


FIG. 8.—A grid station for transforming to high voltage for feeding the grid.

can, therefore, compete successfully with coal for this purpose.

Is electricity likely, in the post-war period, to compete successfully with coal in the sphere of heating? If some method of utilising electricity can be devised which will have an efficiency three times greater than previously, the ratio of 150 to 50 therms actually available to the consumer per ton of coal consumed when using raw coal and electricity respectively, can be made equal, with the elimination of smoke and fumes and much of the labour. Actually, such a method has been known for many years and was propounded by Lord Kelvin at the end of the last century, in the form of the "reversed heat cycle." He showed that if heat is taken at a low temperature from the atmosphere or any other convenient substance and then "pumped up" by a suitable machine to a higher temperature, a much larger amount of heat energy at the higher temperature can be delivered than is used by the machine in the form of mechanical or electrical energy to do the work of "pumping." An electric refrigerator is really a machine which withdraws and rejects heat from the material placed within it to be cooled, as can be observed in any domestic refrigerator, which passes a current of warm air into the room in which it is working. The refrigerator is such a machine as has been described above provided its operation is reversed. Depending upon the circumstances, it is possible to obtain from two to four times as much heat energy from the reversed refrigerator as is actually put in. Only one or two of these have been operated in this country but a large number have been in operation in America for some years. The "Mobilaire" unit developed in America for small office and domestic heating has a cooling, or alternative heating, effect of 6,600 B.Th.U's per hour, i.e. it can be used either to cool the room or to warm it as required. It will maintain an indoor temperature of 80°F. with an outside temperature of 95°F. when working as a refrigerator. When working as a "reversed refrigerator" it will heat the air and deliver 6,600 B.Th.U's per hour of heat into the room at 75°F. when the outside air temperature is 55°F. The electric motor which drives the unit consumes 0·85 kW's (1·1 h.p.) or 2,900 B.Th.U's of equivalent heat energy per hour to deliver 6,600 B.Th.U's of heat per hour, i.e. it will deliver as heat 2·28 times the amount of equivalent electrical energy used to run the machine. This apparent paradox of obtaining an "efficiency" of 228% is explained by the fact that, for each heat unit paid for and used as electrical energy, 1·28 heat units are already available in the air or water for "pumping up" to the higher temperature. A very much larger installation was installed at the Zurich Swimming Hall in place of an installation of six coke-fired boilers for heating the water and the buildings, and, later, another large installation at the Zurich Town Hall. In the former case, the quantity of heat pumped in for the equivalent heat per electrical unit used was in the ratio of 7 : 1. A large building erected in Norwich in 1940 has been made the subject of a careful experiment to ascertain the relative efficiencies of building heating by coal firing, by electricity and by a heat pump respectively; the results of the experiment will be available for publication some time after the war. Within the limits of use for which this type of plant may be employed, the above developments appear to offer a wide field of opportunity for the electricity supply industry to take the premier place in helping to solve our post-war fuel conservation problem. On these latter grounds, the lighting and power requirements of the nation can be met efficiently only by the extended use of electricity: the contribution of the electricity supply industry to space heating may become equally important.[1]

Rural Electrification

For various reasons there was practically no development of electricity supply outside the borders of urban areas prior to 1919. Credit must largely be given to the company undertakings for commencing electricity supply in rural areas subsequent to 1919, when the restrictions on overhead lines were removed. Within a few years it was seen that the extra-urban development would be profitable, and from 1925 there was considerable development of the

[1] A more detailed article, "The Heat Pump", by Dr. T. F. Wall, will appear in the next issue of DISCOVERY.

suburban and semi-rural areas. By 1930, competition was beginning between company and municipal electricity undertakings, and between various promotors of companies to acquire the statutory right to acquire the undeveloped and unmonopolised areas for electricity supply purposes. By 1940, practically the whole of the country had been divided into authorised areas of supply and allocated to either a company or a municipality, holding the exclusive right to supply. Some idea of the growth of supply of the whole industry may be gained from the following table:

Year.	*Units sold for*		Number of Consumers (estimated) Millions.	*Average Price*	
	Lighting, Heating and Cooking.	*Power*		*Lighting, Heating and Cooking.*	*Per Unit sold for—Power.*
	Millions of Units.			*Pence per Unit*	
1928	1708	4537	2·6	3·39	0·94
1929	2036	4926	2·99	3·05	0·86
1930	2344	5908	3·47	2·86	0·82
1931	2744	5371	4·01	2·67	0·81
1932	3071	5435	4·65	2·54	0·79
1933	3469	5693	5·37	2·41	0·77
1934	3916	6392	6·11	2·28	0·73
1935	4535	7285	6·9	2·13	0·69
1936	5505	8250	7·7	1·92	0·66
1937	6454	9312	8·7	1·8	0·65
1938	7348	10422	9·5	1·69	0·64

There is no doubt that the electricity supply industry has a special part to play in the post-war future as regards the development of the rural areas and agricultural industry of this country. The Scott Report stated that "The supply of electricity is an essential service which in due course should be available in the home of practically every citizen in town and country alike, at no higher price to the consumer in the country than in the town". The Report further recommended "The provision of a supply (of electricity) within a given period of years after the war, to every village of 250 inhabitants or over throughout the country and the laying of a free service line to every dwelling or other occupied building therein". Steps are being taken by most of the supply authorities to implement this latter recommendation. The bigger problem exists in providing supply to the more isolated dwellings and farms, outside the community of 250 and more. The real key to complete rural electrification lies in the development of the mechanical load of agriculture such as ploughing, etc. With the development of efficient and cheap apparatus there has been a remarkable growth in the demand in the farmhouse and buildings. Operations such as milking, grinding, water pumping, etc., are becoming electrically operated as a matter of course and have resulted in a satisfactory financial return on what may be termed the "outer fringe" of rural electrification. But if the large requirements for power on the land can be met by electrical means, there then will be such an improvement in the financial returns from rural electrification and such improved characteristics of the load, that the first recommendation of the Scott Committee referred to above, will easily be realisable. The Electrical Research Association and some of the electrical engineers are now devoting considerable attention to the problems involved in developing suitable apparatus and methods for ploughing by electricity.

The Future

Consideration of the future of electricity supply in this country must necessarily be speculative. As far as power station development is concerned, it is unlikely that the spectacular rate of improvement in the efficiency of burning coal and utilising the heat will continue indefinitely, so far as the steam turbine is concerned. The increased capital cost for steam turbo-generator plant which is incurred to obtain a small incremental improvement in efficiency is becoming prohibitive. Consideration is being given to means of using some portion of the 60% of low-grade heat which is at present rejected in the cooling water passing through the condenser. There is a possibility of using some of this waste heat in blocks of new buildings. The development of the internal combustion or gas turbine may, however, permit of further large advances in efficiency. Developments will undoubtedly move in the direction of utilising all hydro-electric resources, and tidal development schemes, and ultimately in the development of sources of natural energy latent in materials other than coal.

In the field of artificial lighting the electricity supply industry has moved already from the wasteful method of heating a piece of metal till it glows sufficiently to produce light, to methods approximately more closely to the ideally efficient light of the firefly—a light without heat. Electric lamps are now being used in which gas particles are excited by an electric discharge to produce "cold" light.

The chief contribution of electricity to the immediate future will rest upon its ability considerably to reduce household labour and to eliminate smoke and fumes. In the domestic sphere, a housewife in a 10-roomed middle-class house and a family of four, has found that she can have immediate hot water for all household purposes (Cooking, baths, washing, etc.), by turning a switch and arranging for the power station to burn 8½ lb. of very low-grade coal each day, so as to generate 7 electrical units. She can use the same trouble-free service to do all her cooking, and instead of having to burn a considerable amount of high-grade coal each day with the consequent household labour involved, the power station will supply her with clean high-grade heat by burning only 7·5 lb. of the lowest-grade coal which might otherwise be unmarketable.

The reorganisation of the electricity supply industry which appears to be imminent should result in considerable advantage to consumers. Voltages and characteristics of supply will almost certainly be standardised so that motors and other electrical apparatus can be used anywhere in the country. Methods of charging for electricity can and ought to be standardised so that, ultimately, one consumer using a given number of units will pay exactly the same as another consumer with the same consumption.

FIG. 1.—The mode of occurrence of fireclays. At the top of the quarry face is a thin layer of boulder clay. Below this is a coal seam underlain by a bed of fireclay about six feet thick.

Clays

ARTHUR BRAY, M.Sc., A.Inst.M.M.

CLAYS of various types are important in any industrial community. They are used in such occupations as brick and tile manufacture and oil well drilling; the manufacture of china; for refractory linings for furnaces; in the textile industries, and in compounding rubber and the refining of oils.

Extreme fineness of grain and softness, is possessed by all clays in common. Most of the minerals present are of flakey shape and sub-microscopic in size. The clays therefore have an enormous total internal surface area. This great area of the crystals making up the clay, determines to a large extent the characteristic adsorptive properties of clays. Much colloidal matter is usually present and there may be a considerable amount of organic matter. Many of the clay constituents are secondary in origin and have been formed by the chemical weathering of felspars, volcanic glasses and ashes, and other constituents.

The Minerals of Clays

Because of the extremely small size of the minerals forming clay, their study is rendered very difficult and X-ray and other methods have frequently to be employed. In the clays such as bentonite and fuller's earth, montmorillonite (Mg O, Al_2O_3 $5Sio_2$ nH_2O) is characteristic and is formed from the decomposition of volcanic glasses and ashes. Beidellite, (Al_2O_3 $3Sio_2$ nH_2O) is also characteristic together with nontronite Fe_2O_3 $3Sio_2$ nH_2O)

In some clays such as the China clays, the Kaolin minerals (Al_2O_3 $2Sio_2$ $2H_2O$) are prominent. Pyrophyllite

(Al_2O_3 $4Sio_2$ H_2O) frequently occurs and resembles to some extent the white micas. Iron pyrite (FeS_2) calcite ($CaCO_3$) and siderite ($Fe CO_3$) are often present as secondary products in many clays. It is seen therefore that, chemically, most clays consist of hydrated alumino-silicates of extremely small grain size, together with much colloidal material.

An important characteristic of many clays is their capacity for base exchange, and the physical condition of the clay may depend on the nature of the base present. When the clay is in contact with solutions, the base ion in the clay may change places with the ion in the solution. In this way sodium, calcium and hydrogen clays may be formed. Sodium clays deposited in salt water are unflocculated and allow .the slow passage of liquids and gases. On the other hand the calcium clays deposited from hard fresh water are strongly flocculated and are more permeable than the sodium clays, whilst the hydrogen clays are highly dispersed and impermeable.

Formation of Clays

Clays may be formed from land derived material and deposited as sediments in lakes or in the sea at a distance from the shore lines. When freshly deposited from water, the clays or muds may have great amounts of water still enmeshed between the grains, especially if much finely divided organic matter is present. In this state the mud is very fluid. If increasing weight so applied due to the weight of overlying sediment some of the water may be expelled from the clay and its pore space reduced below about 75% when the clay becomes plastic rather than fluid. With increasing weight much of the water may be squeezed out, some re-crystallisation may take place and the clay be compacted into a mudstone.

The fireclays found below many coal seams are of a different character. These clays are usually full of plant rootlets, and it has been suggested that fireclay may represent the soils on which the vegetation of Coal Measure times grew. The vegetation would exhaust the soil of lime and alkalies, and the upper layers of a fireclay bed are usually of more value than the lowerlayers.

The china clays are formed by the weathering of granitic rocks by the action of carbon dioxide or of carbonated waters on the felspar crystals in the rock. The industrial uses of a clay is determined by its chemical and structural constitution.

FIG. 2.—The appearance under the microscope of a fireclay. The extremely fine grain is noticeable. The rosettes are pyrite in radiating needle-shaped crystals.

Bentonite and Fuller's Earth

The bentonite clays are greatly valued because they have a large capacity for base exchange, and because the clay will absorb organic dyes and other substances to a marked degree. The bentonites are found chiefly in the strata of Ordovician and Cretaceous age in North America and are light green or greenish yellow in colour. When moistened, bentonite swells greatly and then breaks down to a smooth paste. With excess of water the clay rapidly becomes a slime. The clay absorbs about eight times its own volume of water and consists mainly of minute crystals of montmorillonite. It has therefore a large internal surface area to which the clay owes its adsorptive properties. Bentonites are formed by the devitrification and chemical alteration of volcanic glasses and ashes. The alkalies and much of the silica are removed, whilst water, magnesium and iron are added. The bentonites are usually stratified and occur in thin beds of uniform type over considerable areas. They usually are unfossiliferous.

Fuller's earth is a clay to some extent similar to bentonite and is used in the cleaning and whitening of wool because of its degreasing properties. The clay absorbs oils, grease and water and is extensively used in the clarifying and decolouring of oils. In England, fuller's earth is much quarried in Surrey and Somerset. The clay is massive and when dry is extensively fissured. In water the clay crumbles and falls to pieces. It owes its adsorptive properties to the presence of minute crystals of montmorillonite, which, as in the bentonites, has been derived from the devitrification of a volcanic glass or pummice. The normal constituents of rocks formed by the wearing away of land masses are scarce or absent and the clay was formed in quiet lagoonal conditions.

China Clay

China clay falls into a different category. Bedding is absent and organic remains are uncommon. China clay is genetically associated with granitic rocks and has been formed by the action of carbon dioxide or carbonated waters on the felspar crystals which are an essential

constituent of granitic rocks. The source of the clay in the case of the deposits in Cornwall was probably the gases given off during the cooling of the granite melt, acting on and decomposing the felspar crystals of the cooling rock. Normal atmospheric weathering however may have had considerable influence in the production of the clay. In Bavaria a seam of brown coal rests on granitic rocks. Solutions passing through the coal have attacked the felspar crystals of the underlying rock and led to the formation of a kaolin deposit. The felspars are probably first altered to secondary mica and then to kaolin in very minute crystals. In the quarries the clay contains much quartz, mica and tourmaline, representing the unaltered minerals of the granite. These impurities are washed out during the purification of the clay. China clay is smooth and white in colour and is used extensively in the manufacture of pottery, in the paper making industry, and in rubber compounding. It also has uses in the paint industry and as a stiffener in textiles.

Near Bovey Tracey in Cornwall beds of kaolin clays and pipe clays are worked. These clays were formed during late Geological times from material washed down from the Dartmoor area by streams flowing over the decomposed granite. The deposits were formed in a lake. The coarser quartzose material was deposited as a delta at the north-western end, whilst the finer clay portion was washed further out into the lake forming beds of pottery and pipe clays which are now quarried.

The fireclays form a special group of clays. Their refractory properties makes it possible to fire them in kilns at high temperatures. Fireclay is used in the manufacture or refractory bricks and sanitary ware and terra-cotta. Its ability to take a glaze enables fireclay to be used in the production of ornamental tiles, vases, etc. The clay shrinks on firing and this has to be allowed for in making the moulds. Beds of fireclay are found below coal seams. (Fig. 1). The clay is grey to black in colour depending on the amount of organic matter present and may be smooth to the touch if the proportion of silica grains is not very high. Some clays have a large amount of silica and approach the siltstones in character. The upper portion of a fireclay bed is often lighter in colour and of better quality than the lower layers and is often kept separate for use in the manufacture of better quality ware. If much copper sulphide is present in the clay it may lead to blotches on the finished articles. The alkali and lime content of the fireclays is small and the silica content of the more gritty varieties may be fairly high.

Beds of ordinary plastic clays suitable for brickmaking, such as the London Clay of Tertiary age and the Gault Clay of Cretaceous age, outcrop over very many square miles of South East England. Their outcrops are marked by innumerable clay pits. These clays were usually deposited under marine conditions largely from sediment brought down by rivers and streams.

In some tropical and sub-tropical areas bauxitic clays are found which if the alumina content is sufficiently high and transport facilities are available, may be worked as a source of aluminium.

JUNIOR SCIENCE

Something about Hot Air

THE other day, when we talked about the melting of ice, I told you that the effect of heat on a solid substance is to make the molecules vibrate more and more violently until at last they break away from each other. Then the solid substance melts. Water (H_2O) like most other substances can exist in three different forms: solid, liquid and gaseous. By heating we can melt a solid to become a liquid and evaporate a liquid to become a gas. The next question is, of course, what happens to a gas when we go on heating it?

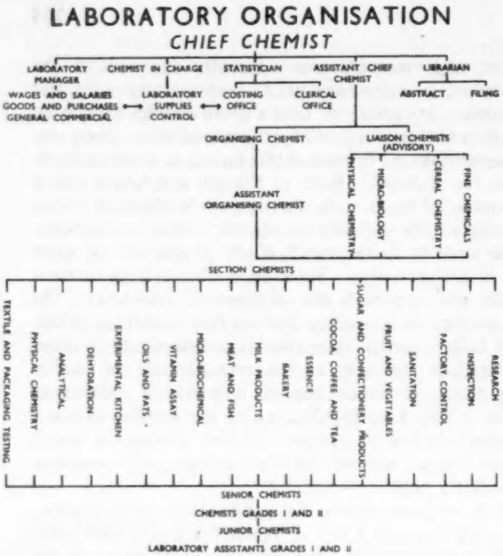
We can find that out by making an experiment or two. First we need a gas. Well, there is an ample supply of ordinary air all around us which is a good gas to experiment with. Heat can be provided by a jug of hot water. Take an empty bottle*—that means, of course, a bottle filled with air—and hold it upside down into hot water. (Fig. 1.) You will see that as soon as the bottle and the air in it gets hot, air begins to bubble out of the bottle. Next, smear the stopper of a bottle with grease or vaseline and cork it up lightly. When you immerse the bottle in hot water (Fig. 2) the stopper will be blown out. This shows: heat makes a gas expand; the expanding air bubbles out of the inverted bottle when heated. Also, if the gas cannot expand because the bottle is corked, heat makes the pressure of the gas increase until the stopper is blown out.

FIG. 2

FIG. 1

All this is very important. For example, the engines of cars and aircraft work by expansion of heated air. The object of burning petrol in the cylinders of these engines is simply to heat the air in them and make it expand. In turn, the expanding air drives the engine. K.M.

*Use a baby's feeding bottle, it will not crack in hot water.



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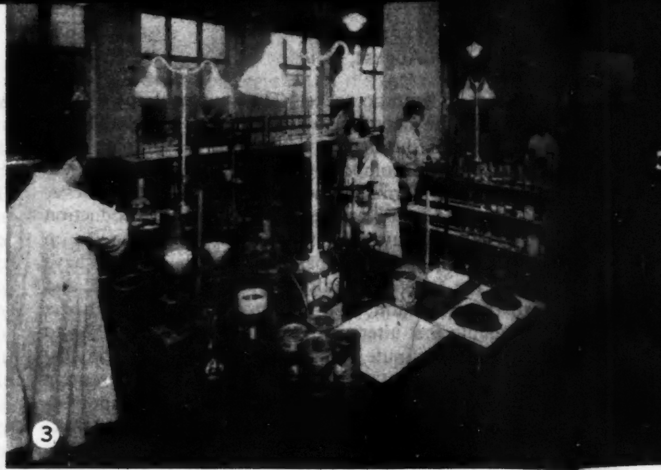

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A Food bo

LARGEST of Britain's food laboratories is that maintained by J. Ly Co. Ltd., th of the laboratory is process control, which ensures that the fo ked in the factories are up to standard. In addition research is carried on he aim of in new recipes. A considerable amount of fundamental research dertaken by activity are organised under various sections which deal with spe asses of foo sections is integrated in the manner indicated in Fig. 1. Started ars ago, thi science graduates; the steady growth of the staff is seen in the g (Fig. 2).

Samples of raw materials and manufactured productions are ually being analytical laboratory. Many of the instruments are familiar, as f tance the p determinations. Others are unusual: the farinograph (Fig. 5) is strument fo (seen below the burette) into which the flour sample is introduced ter is added by means of revolving blades to make a dough, which offers resist to the rotat scale and is recorded on the travelling graph paper held by the (right). Th the "strength" of the flour, and in the same operation the wate orption is c correlated with what will happen on baking.

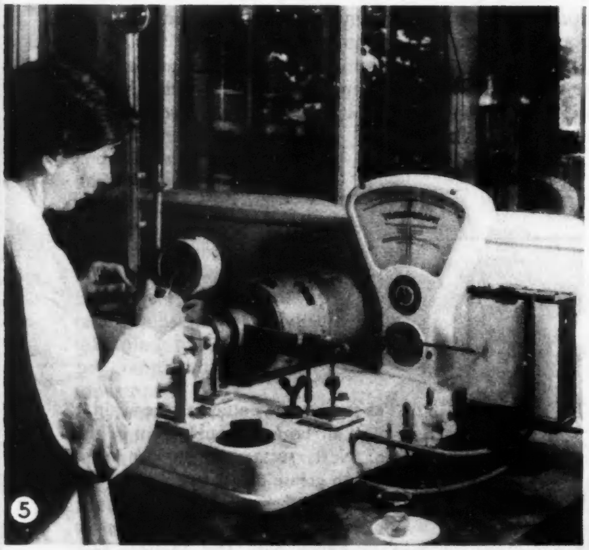
Fig. 6. A Majonnier tester, by means of which the total solids a ts in milk, half-an-hour.

Fig. 7. A photograph of the textile testing laboratory, where a pping mat

Fig. 8. The enormous difference between cookery on the kitch cale and fo new recipes in a pilot plant. The photo shows a new formula fo nfectioner tures the factory equipment which will be employed.

Fig. 9. The library. Here are 1200 reference books. 90 period are regula is used. The index is continually being supplemented; at presen ontains ab

Fig. 10. Experimental ovens allow close investigation of bakin oblems. Th



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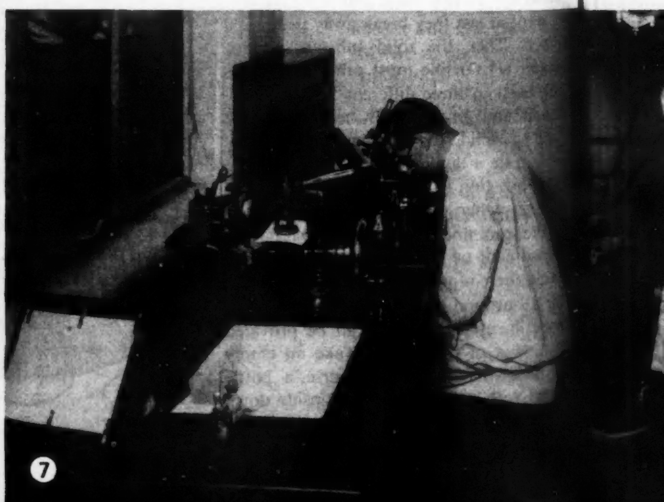

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ood boratory

ntained by J. Ly Co. Ltd., the well-known catering firm. One important concern ures that the foo ked in the firm's kitchens and of the products prepared in its ch is carried on the aim of improving processes of manufacture and of perfecting nental research dertaken by other members of the staff. These three kinds of ch deal with spec asses of foodstuffs (e.g. sugar, milk, flour) and the work of these Fig. 1. Started ars ago, this laboratory has a staff of 200 persons, including 90 f is seen in the g (Fig. 2).

roductions are c ually being taken and tested. Fig. 3 gives a view of the general are familiar, as f tance the polarimeter (Fig. 4) which is in constant use for sugar graph (Fig. 5) is strument for testing flour; its essential feature is a mixing bowl ple is introduced ter is added from the burette, and becomes mixed with the flour hich offers resist to the rotation of the blades. This resistance is indicated on the per held by the (right). The shape of the curve obtained affords a measure of eration the wate orption is determined; both qualities can, from experience, be

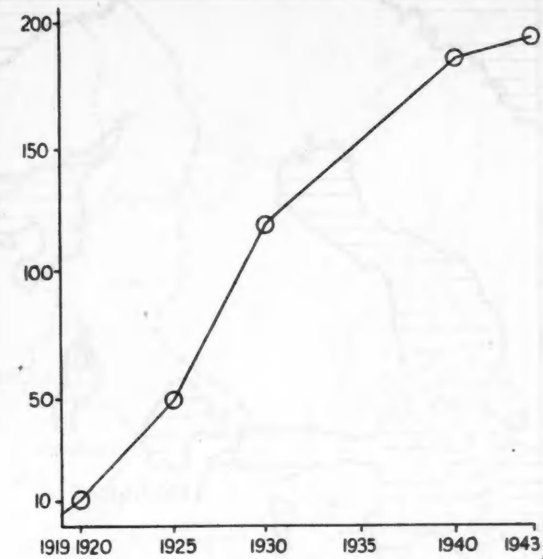
the total solids a ts in milk, ice cream, etc., can be estimated in a matter of about

oratory, where a pping materials are tested.

ery on the kitch cale and food processing in the factory is bridged by trying out new formula fo nfectionery mixture being tested, using apparatus that minia-ed.

ooks. 90 period are regularly filed. For indexing the Universal Decimal System nted; at presen ontains about 50,000 references.

igation of bakin blems. The rise of puff pastry is here being tested.



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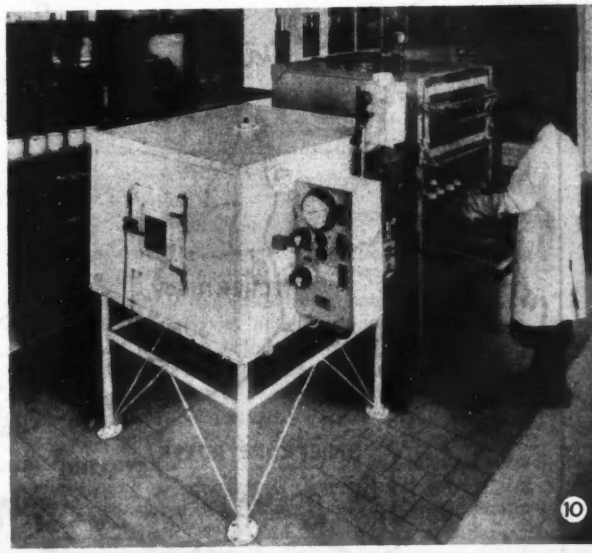

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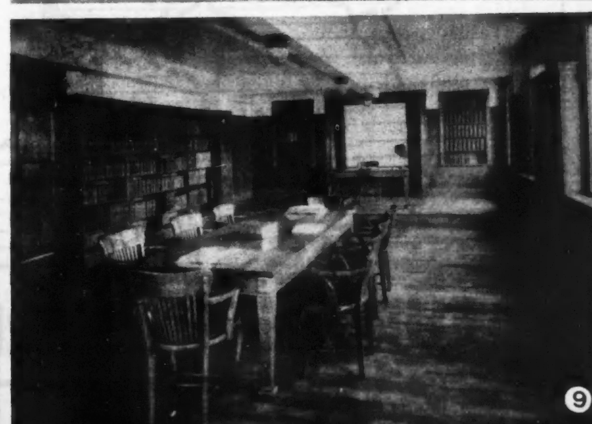

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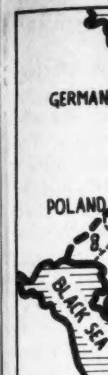

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Food Strategy of the Soviet War

F. LE GROS CLARK, M.A.

Viewed as the solution of a series of complex technical problems, the war-time food economy of the U.S.S.R. shows some remarkably interesting features; and we already know sufficient about it to venture on a brief study of its main trends. The problems that confront our allies have differed in many respects from our own, though there are certain recognisable similarities such as always exist between two great industrial countries in time of war. In the nature of things we shall have to concentrate upon the technical aspects of the Soviet solution; and yet in dealing with Soviet practice one is necessarily conscious of passing into a new economic dimension. Much has to be explained or taken for granted. There are novel values, subtle changes in the relationship between man and man. Above all, the scene is vast and shifting; and its currents are not readily to be interpreted by a writer, who lacks the artistic power of "turning the accomplishment of many years into an hour-glass". Our safest way is to rely upon the flat narrative of events to convey its own meaning to a well-informed reader.

It may be noted that in speaking of their liberated territories the Russians seem to use rather the term *restoration* than the term *reconstruction* so commonly applied to the occupied countries of Europe. In other words, their aim is to re-establish as soon as possible the normal trends in Soviet agricultural development that were already manifest before the war. Invasion has, of course, violently disturbed the expansion of Soviet agriculture especially that of live-stock farming, even if the levels of crop production can be fairly rapidly restored. The destruction of live-stock in the west has been on a vast scale. Only over a period of years can the total numbers in the Union be brought to their pre-war level; and inevitably the curve of live stock expansion in the Union will show a trough for 1941-44 as deep as or even deeper than that shown in the years 1932-3. This period 1932-3 had been the phase of early collectivisation, when the steep decline in the numbers of live-stock reflected the bitter struggle that was taking place in the countryside. The number of cattle fell from 67,000,000 in 1929 to 38,000,000 in 1933, that of sheep and goats in the same period from 146,000,000 to 52,000,000; and finally that of pigs from 20,000,000 to 11,000,000. From the year 1934 recovery set in. No estimate can yet be given of the losses experienced in 1941-44; they must be severe, but

KEY TO MAPS OF U.S.S.R.

1.	Russian S.F.S.R.	5.	Lithuania	9.	Georgia	13.	Uzbek
2.	Karelo-Finland	6.	Byelorussia	10.	Armenia	14.	Tadjik
3.	Estonia	7.	Ukraine	11.	Azerbaidjan	15.	Kirghiz
4.	Latvia	8.	Moldavia	12.	Turkmen	16.	Kazakh

it is possible for several reasons that they have not been quite as catastrophic as they were in the earlier period, though we must realise that by 1941 the cattle and sheep were only approaching their 1929 peak. The pigs had well surpassed it.

Eastern Basis of Production

The most important aspect of Soviet agricultural policy has been the shift of production from west to east. This was proceeding long before the invasion; and it has been the salvation of the country. The aim was doubtless partly a strategic one; but it was also a feature of Soviet policy to broaden the bases of farming in every region of the Union. The chief crop to be considered was wheat. The shift here to the east from the productive areas of the Ukraine and the North Caucasus began as early as 1930. In a speech in March 1939, Stalin stated that during the previous ten years the basis of market grain had moved progressively to the north and east; in fact, the Ukraine's annual market deliveries of grain had, for three years before the war, been little more than a third of the total deliveries for the whole Union.

The shift in potato production began somewhat later. Until 1939 potatoes had customarily been shipped from west to east for consumption; but by 1941 the new industrial belt around the Urals was already self-supporting in potatoes and cultivation was expanding far into Siberia and Central Asia. Sugar beet was a slower crop to establish itself in the east; and this raised several problems in the early period of the war. The Ukraine was still probably responsible for about 70% of Soviet sugar, since the beet was processed near the areas of production. Some development had, however, taken place in the eastern republics, especially in Kirghezia and to a far smaller extent in Kazakhstan. The sugar situation was relieved for a moment in 1941 by shipments of sugar through the Persian Gulf, mainly from the Netherlands East Indies; but the Japanese advance brought this to an end and from that time the U.S.S.R. has had chiefly to rely upon its own eastern expansion.

Farm Mechanisation

The secret of Soviet farm production lies technically in the tractor and the combine harvester. The distribution of these machines within the Union represents in no small measure the relative importance to the government of the different regions of the Union. For ten years before the war there had been a rapid growth in the number of tractors, tractor stations and skilled operatives in the expanses east of the Volga. The line of the Volga is a convenient division to take, since it divides the secure eastern areas from the invaded or threatened territory of the Union, even though there are great stretches of farm land west of that river that fell at no time under German control. We may remark, then, that in 1938 there were already 218,478 tractors east of the Volga out of the total of 483,513 possessed by the Union (approximately 45%); and out of a total of 153,792 combines there were 78,686 or 51% in the east. But the war brought its own problems. A certain proportion of these tractors had to be mobilised for military purposes; and skilled men were called to the colours. Spare parts were frequently in short supply; and prior to the war the producing areas in the Ukraine and the Kuban had been able to rely on near supplies of petrol from the Transcausian oil-fields, whereas the war was imposing severe burdens on internal transport. The problems were partially solved by training fresh drivers and mechanics, frequently from among the women and the older men, by making each tractor take an extra load and awarding to the operatives such bonuses as would represent to them their intimate interest in the production drive, and finally in 1943 by adapting tractors gradually to gas-generator fuel which was expected to save 6 to 8 tons of petrol per tractor in the season.

Since so large a proportion of the farm machinery was still concentrated west of the Volga, it has been a matter of moment to the Russians to discover what had happened to it under the German occupation. There had been probably 20% or so of all the Soviet tractors in the Ukraine and a further 10% in the areas north of the Caucasus. The remaining 25% had been in middle and north Russia. Thus the existence of somewhere near 40% of the tractor force of the Union had been seriously threatened. Some early evacuation of tractors did indeed take place; but it was not on a large scale. For example, the Ukraine east of the Dnieper managed to get out rather over 1,300 of its tractors before 1942. The Germans systematically destroyed both tractors and tractor stations in their retreat; but they were less thorough than they would have desired. Tractors were concealed by the farmers. In the Moscow region, for instance, which was liberated after a brief occupation early in 1942, some 500 tractors were recovered from their hiding-places. It was reported in March, 1944 that in the Ukraine east of the Dnieper about a third of the pre-war tractors were still surviving, on some farms rising to a half; but most of them required overhauling or capital repairs. By that date all the machine tractor stations that had existed before the war, 570 in number, had resumed operations in the area; and a ploughing campaign of 10,189,000 acres under summer crops was projected.

The tractors had been of comparatively little value to the German armies of occupation. This was due not merely to their complete inability to supply adequate fuel. Numbers of skilled operatives had been withdrawn into the interior; and those who remained were not likely to use their skill. The fields were, of course, cultivated in a manner. Farmers and their families have to struggle to live, even under a brutal occupation; and the Ukraine is an area of comparatively dense rural population, a large percentage of which has contrived to survive the invasion. But an organised collective farm is able to design methods of quiet sabotage that are beyond the power of the isolated peasant. Many of the farms were under cultivation when the Russian armies freed them; and it was possible immediately to reap and lift a harvest of a kind.

Problem of Wheat

As we have already mentioned, the problem of internal transport was bound to become a serious one for the Soviet government; and one of the keys to Soviet success in ensuring its food supplies has been the policy of localising and regionalising production. This policy of

FIG. 1.—A. Kovalenko, chief of the tractor brigade of the Kurman Machine and Tractor Station, checking the work of a tractor driver. To the left is a Stalinets diesel tractor made by the Chelyabinsk Tractor Works.

establishing areas of relative self-sufficiency is a perfectly normal one and was in practice well before the war. The question of bread-grains was clearly the most important. The Russians are far higher bread-consumers than are the peoples of Britain or of North America. It seems probable, for example, that even in pre-war years the average Russian still relied on bread and potatoes for more than 60% of his daily energy, as compared with a level of 30% to 40% with the average consumer in our own country. In war-time the Russians' reliance on bread has necessarily tended to increase, since meat, sugar and fats have been in very short supply. Thus the extent to which bread-grains, mainly wheat, had in the pre-war years to be transported from region to region was still significant. The chief surplus regions were Western Siberia, from which over a million tons of wheat were moved annually to Central Asia and the east, and the south and south-west regions of European Russia, from which about 6 million tons had to supply the deficit both in the north and the regions beyond the Caucasus. To meet this problem and to raise the total provision of market grain, an extensive plough-up policy has been adopted. Early in 1944 it was reported that Georgia had expanded her cultivated area by 200,000 acres; and Azerbaidjan had in the same period increased the area under winter grain by 250,000 acres. The main areas of development appear, however, to have been in Kazakhstan and its neighbouring republics. In Kazakhstan, for instance, expansion had been continuous in 1942 and in the spring of 1943 a fresh area of a million acres of virgin soil was ploughed up. But progress in the whole Union in 1942, while significant, had not made a high contribution to the total acreage; it had represented about 5 million extra acres under cultivation, of which about half was under cereals.

There had been before the war more than 140 million acres under crops of various kinds in the regions east of the Volga. But in 1943 the work was advancing rapidly; the sown area of that year was increased by 16 million acres, of which 9 to 10 million acres were under grain. The increase in the present year is to be one of 18·6 million acres above the 1943 level; and this excludes all the westerly regions of liberation; a large proportion of the newly ploughed land is going down to grain.

Localising Food Production

The practice of regionalising farm production to save transport and labour has been applied further and refined in many ways. Sugar beet production has been developed slightly in the republics beyond the Caucasus but extensively in the Asiatic republics. By the summer of 1943 there were two new refineries at work in Kirghezia with a third shortly to come into operation; Uzbekistan had apparently established four refineries, the first in the

republic, since the beginning of the war. Another area of expansion has been Kazakhstan, where fresh farm-lands were brought under a completed irrigation scheme in 1942 and the area under beet was three times that of any previous year. Some of these sugar-processing plants were evacuated from the west in accord with the Soviet practice; and most of them were probably new factories. How far the Union will be able in the coming year to restore its western sugar bases, remains to be seen. Beet was cultivated under the occupation and some of the produce was shipped to Germany; but during the German retreat the destruction of refineries was on a large scale. Most of the mills were destroyed in the regions of Poltava, Kharkov, Sumy and Chernigov; but in the Kuban a mill was preserved through the initiative of one of the engineers, who buried the key parts of the machinery; and in Kiev some of the plants were at work on the 1943 crop only six weeks after the Germans had been ejected from the town. By the March of 1944 eleven of the mills in the territory freed during the previous year were already restored and had fulfilled their allotted programme.

To revert to the regionalisation of production in regard to sugar, it is worth remarking that early in 1944 it was decided that all beet should be cultivated only within a radius of 20 kilometres of the reception depots; in areas with trunk roads the radius might be extended to 25 kilometres.

This concentration on local production has covered most of the crops for human consumption, as well as such industries as pig-rearing, egg-production and dairying. The regions have, of course, to consume such food-stuffs as are available to them in varying degree; but, allowing for that, it was possible for the U.S.S.R. to claim that in the first six months of 1941 the proportion of "locally produced" food had been one of 24·5% (presumably calculated in terms of the weight of food carried). In the autumn of 1942, Kovalev, the Assistant Commissar for Internal Trade, stated that in the corresponding period of that year the proportion of locally produced food had risen to one of 31·4%; it has since increased and may be approaching 40% or 45%.

Much of this result has been produced through the expansion of the grain area in new regions, but still more through the development of vegetable cultivation in the belts about the towns and the areas of industry and mining. A large expansion of such market-garden belts had taken place in the years immediately prior to the war; and in the course of the war it has become necessary for every factory, school, hospital and institution to supply itself from its own farm and garden estates. Needless to say, a considerable number of them possess large pig farms for the conversion of their waste.

Losses of Livestock

There are no figures yet available to show us what proportion of the total live-stock the Germans have liquidated in the western areas of the Union. In that area of Russia, which had lain secure from invasion east of the Volga, there were before the war about 40% of all the cattle, 50% of the sheep and goats and less than 25% of the pigs. But in the Ukraine and in the regions north of the Caucasus there were probably concentrated some 23% of the cattle, some 15% of the sheep and goats and some 30% of the pigs. The figures may not be very precise; but they probably represent the general proportions. The Germans not only had a system of requisitions and of exchanging clothing or lengths of fabric to the farmers for a deposit of cows or pigs; they also slaughtered extensively for the provisioning of their armies and, in the course of their retreat, instituted a policy of virtual extermination. In the Stavropol territory, for example, more than 60% of the horses had vanished and what must have been well over 70% of the cattle; the farms of the Kursk region had owned collectively some 2½ million head of poultry, and of these, after the date of liberation, only 9,000 head were counted. These may be extreme instances. Yet comparatively little could be done either through early evacuation or concealment. In the richly stocked area of the Kuban the farmers were found to have preserved in the woods and marshes some 24,000 head of cattle, 16,000 sheep and 1,400 pigs. The effort was a gallant one, and in the Kuban as in most of the other liberated regions the cattle sheds and poultry-rearing stations were rapidly got into commission again with stocks of timber supplied by the government. But with the gradual return of live-stock from the areas to which they had been evacuated, and with the liberal gifts made by farms in the interior of the country, it is not anticipated that the eastern Ukraine will possess on its collective farms by the close of 1944 more than 685,000 cattle, 210,000 pigs, 250,000 sheep and goats and 2,500,000 head of poultry. The numbers of live stock in the possession of individual households we have no means of assessing. The fall was probably less extreme; but it is not easy to avoid the conjecture that the occupied regions have lost, in varying degrees from region to region and stock to stock, 60% to 80% of their original herds.

Relief and Re-Habilitation

The policy of the U.S.S.R. in affording immediate relief to its liberated towns and villages has a pathetic interest for us, in our contemplation of the overwhelming problem of an occupied Europe. It is evident—and the Soviet Government is well aware of it—that to be re-occupied by one's own nationals is an easier proposition for a population than to be liberated by an alien force, however friendly that force may be in theory. Moreover, the Soviet armies carry in their wake a tide of relief in the form of food, stocks and equipment poured out from the generosity of a warm and ecstatic people. Technically the transition from a purely military to a joint military and civil administration is a rapid one. In several instances a civil authority has moved into a town almost at the same moment as the relieving forces; a Soviet education office has frequently been at work two or three days after the retreat of the Germans. There is, however, no question in the mind of the government as to the work expected from these liberated areas. "The keynote of the restoration process," said President Kalinin in the autumn of 1943, "is that the liberated town or village shall, as soon as possible, join in the common labour for the front, and that each town shall increase the total volume of war production."

There has been no census made at the time of writing to

FIG. 2.—Red Army men helping collective farmers to gather in the harvest.

determine precisely what percentage of the pre-war population still survives in the areas of liberation. The extent of evacuation eastward had varied; and since it included not merely children with their mothers and teachers but frequently a high proportion of industrial workers, the drain was naturally large. About half of the three million or so of the inhabitants of Leningrad were evacuated before the siege began; and the departure from Kharkov and Kiev was probably no less extensive. From a few industrial towns such as Dniepropetrovsk the withdrawal may have been even larger. On the other side we have to reckon the removal of population to Germany, which was stated even by the close of 1942 to have reached a level of more than 700,000; and of those who died from starvation, exposure and violence we can give no present account. Yet from the countryside the evacuation had been relatively low; and, destructive as the Germans may have been, they cannot have exterminated a very large proportion of the thirty five million original inhabitants of the territory, from which they were ejected in the course of 1943.

The death-rate in the towns was presumably higher, from whatever cause. When Kiev was re-occupied, it had no more than 20% of its pre-war population of about 850,000. But of those who remained in the towns to face the Germans, some had probably later sought refuge in the villages where food could be secured and partisan resistence could be organised.

At all events, the provision of food, expanded rapidly after the arrival of the Soviet forces. In Kiev, for instance, there had already been 1,840 public dining rooms opened by a date two and a half months after its liberation; and unless their average capacity was very small, the population must have in the interval increased considerably. Stalino a month after its release in early September 1943 had 18 restaurants, 23 bakeries and 11 flour mills in operation. The restoration of food services went forward at the same pace and in the same order in all towns from which we have evidence. Bakeries were invariably among the first plants to be re-equipped; Kharkov a month after liberation had several mechanised bakeries already at work as well as departments of its meat combine; there is further record at the same period from Kharkov that 46 grocery stores had been opened and some 60 canteens catering for approximately 50,000 factory and office workers together, no doubt, with many others catering for the general population. These figures give perhaps some measure of the speed of recovery; but they give no indication of the extent of devastation. About 25% of all farm dwelling places in eastern Ukraine had been burned or rendered uninhabitable; and in several towns the destruction of dwellings amounted to 50% or over.

Any attempt to survey the rebuilding and town-planning schemes of the Soviet authorities would be beyond the scope of this brief review. We are concerned merely with the production and supply of food; and it is now clear that large stocks, both of food-stuffs and of cooking equipment and fuel, have been built up at the key points behind the advancing armies for this purpose. They appear to have their own quota of transport and labour attached to them; and they have frequently entered the area with the army. The reports reaching this country, mainly from the broadcasting service, rarely cover more than single areas or partial aspects of the whole complex process; but it is possible to fit carefully together the multitudinous material and to reach a composite picture of it all. If in so doing we have also to "piece out our imperfections with our thoughts", what shall we say further? Only, if you like it, that in the shifting current of events, that now indubitably lies before us, much, if not all, may temporarily be forgot; and that we do well, while memories are fresh, to pay our tribute to one of the most enduring of our allies.

Social Survey goes to War

DENNIS CHAPMAN, B.Sc., (Econ.)

It is often said that this is a scientists war and a great deal is known about the part the natural sciences are playing in the war, but so far the part played by the social sciences has attracted very little notice.

The science of psychology plays a part in the production of our propaganda and in countering that of the enemy; it has been applied to problems of industrial organisation and scientific methods of selecting personnel have been employed with great success in the armed forces. About the science of sociology on the other hand, little has been heard although it has played quite a considerable role in the solution of problems, both in immediate, practical spheres, and in long-term planning.

Great Britain has, in some directions, led the way in social surveys. In the 19th century there were very many social studies made, some of the most important of which were made by the Manchester and London Statistical Societies. This work culminated in Charles Booth's monumental study of the working people of London in the nineties of the last century, a study that created the main lines of the Poverty Survey which have been followed in this country and elsewhere ever since.

This article describes some of the ways in which a development of the social survey method has been applied to war-time problems. It is first necessary, however, to say a few things about the social survey before the war.

The Social Survey before the War

The English social survey has several special features; in the first place it is a polygraph, that is to say, it deals with a great number of topics; in the second it is local or regional rather than national, although very often local surveys try to argue from their special case to the general on the grounds that the survey has been carried out in "a typical provincial town"; and in the third place a characteristic of social surveys in this country is that they have been almost entirely taken up with problems of poverty or problems arising out of poverty.

Apart from those social surveys which have been sponsored by philanthropists, by universities and occasionally by Government Departments, there has been a number of national surveys carried out by Market Research Agencies in connection, as a rule, with their advertising or marketing problems. These have developed a technique of sampling designed to give the main facts about the national markets with the minimum expenditure.

This method of national sampling has been very highly developed in America by the American Institute of Public Opinion—the Gallup Poll, the Fortune Poll and the National Opinion Research Centre. The studies of these polls achieved a notable success when on the basis of quite small samples they were able to forecast correctly American Presidential Election results, whereas Straw Polls carried out by magazines in which millions of people recorded their vote but the voters were not chosen on any scientific basis proved incorrect.

Some typical English surveys are those of Merseyside, carried out by the University of Liverpool, the two famous surveys of York, carried out by Mr. B. Seebohm Rowntree, the local survey of Bristol, carried out by its University and the Regional Studies of the Special Areas, carried out by Universities at the request of the Assistance Board. All these surveys have had the aim either of studying conditions of working class poverty or of studying its causes. The whole field of middle and upper class life has been left untouched, even though it may well be that it has an important bearing on the conditions and causes of working class poverty.

Some studies, however, have been made, not so exclusively concerned with the problems of poverty, but with the problems of community life such as those at Watling, Dagenham and Becontree.

Outside academic sociology, Mass Observation, an organisation initiated in 1937 by Charles Madge, then a *Daily Mirror* reporter, sought to provide qualitative information about the whole of ordinary life by the use of a panel of voluntary observers. The work of Mass Observation has undergone many changes since then; it has combined the voluntary panel with full time observers and has developed work in the field of public opinion research and market research.

The main techniques of the social survey were worked out by Booth and in his study he used the direct interview, the indirect interview (that is the interview where the questions to be asked are introduced in the course of conversation), direct observation and the collection of conversation.

In field work he employed methods that have since come to be known as "Functional Penetration" of a social field, that is making observations whilst having an accepted role amongst the social group being observed; for example he used school attendance officers to collect data about families; and "Participant Observation" of a social field, an example of which was the classic study of Jewish life in the East End of London made by Beatrice Webb who lived and worked with Jewish families as one of them studying all aspects of their life.

Not all social surveys, however, have been based on direct field work. A great many of them have used observations and data collected for administrative and other purposes and correlated them to produce new evidence. The most celebrated English example of this was "Industrial Tyneside" by Dr. Henry Mess which was largely based on the Medical Officer of Health's reports of the Tyneside Towns and Boroughs. A recent example of a survey which gives a partial picture of urban social conditions was "Our Towns", carried out by a committee under the chairmanship of Miss Margaret Bondfield and based very largely upon information obtained by officers and social workers employed in the evacuation scheme. The defect of this type of survey is its lack of quantitative data although it may be argued that no matter how small the extent of such conditions as were revealed in this study,

it is a clear indication that there is a very grievous social problem to be tackled.

A survey which combined field studies with the use of administrative and other data was "Men without Work", a study of unemployment made for the Pilgrim Trust.

A main fault in British sociology has been that it has in a way fallen between two stools. Its local surveys have never been as sufficiently complete to show the working of a community as some of the American studies have, particularly "Middle Town", "Middle Town in Transition" and "Arctic Village", nor have they been representative of the national social problem because of their local character, in spite of the claim of many of their authors to the contrary.

Some impetus has been given to the development of national social surveys by the success of national surveys in other fields like the Land Utilisation Survey of Great Britain directed by Dr. Dudley Stamp, and the Soil surveys and Forestry surveys in Agriculture which have successfully used sampling technique. By combining some of the experience of national surveys undertaken by commercial organisations and those organisations measuring public opinion with the methods of the local social survey, an instrument has been devised for providing administrative information which could not be obtained in any other way.

The War-time Social Survey

In the past when the State wished to know about any particular problem it was more usual to make an inquiry adopting the pattern of the Royal Commision, that is to say, a committee of experts had the job of making a report about the subject under discussion which they did by calling upon interested parties to give evidence. Where the problems involved are, however, connected with the day to day life of the ordinary citizen these methods have limited applications and more direct reference is of value. There is a good deal of evidence to show that in most social problems (as in any other scientific problem) a small sample inquiry is sufficient to show the main factors involved. It is upon this basis that the War-time Social Survey works.

A very large number of Government Departments are now concerned with administering the daily lives of ordinary people, particularly such departments as the Ministry of Food, Ministry of Agriculture and Fisheries, the Ministry of Health and the Board of Trade. In another way the Ministry of Information is also concerned with the problem of keeping the public guided and informed.

These departments have the job of maintaining the physical and mental health of the nation and its efficiency, and doing this with the greatest economy of our national resources. It is, therefore, essential that the probable effect of any administrative decision be known in advance if the wastage of our national resources is to be avoided. For example, if it was thought desirable to change one of our national food habits as was done in the case of bread, the department concerned must be reasonably sure that its attempt will be successful before it embarks on the adoption of such a policy which may involve, as in the case of bread, decisions about imports and about the processing of a foodstuff involving many thousands of people and many thousand tons of shipping. Some 45 comprehensive surveys of food problems have been made by the War-time Social Survey. These cover such subjects as a study of a typical day's meals, the precise food intake of groups of school children and the methods used by housewives in cooking green vegetables—important for estimating vitamin C intake.

The problem of health education is one which is of outstanding importance at the present time and the departments concerned, the Ministry of Health and Ministry of Information need to know, both what is the most effective and economical method of education and also the effect of any particular campaign. The campaign to persuade mothers to have their children immunised against diphtheria is a case in point. A sample inquiry was undertaken to show not only which methods of explanation and education had been the most effective, but also the proportion of children who had been immunised as a result of this campaign. This inquiry showed not only what remained to be done, but also gave valuable clues as to how best to accomplish the remaining task. A similar inquiry has been made about the Venereal Diseases Campaign.

The Ministry of Agriculture and Fisheries have similarly undertaken a major task of education and persuasion with their "Dig for Victory" campaign and need to know to what extent they have been successful and what methods of conveying advice and information are the most effective. It is also necessary that they should know what garden and allotment crops are being grown and by how many people, since the planning of the nation's feeding cannot be efficiently done without this information. A sample survey of a little over 3,000 families gave the required information.

Information on the more simple questions of shortages of household necessities, or of the basic facts required for the "Battle for Fuel", was provided by small sample surveys carried through often in a matter of days.

Work has also been done on long term problems and reports on some of the problems of Domestic Lighting, Heating and Noise have been completed for committees of the Building Research Station who are working on the plans of houses to be built during and immediately after the war. The Lighting Survey involved measuring with a photometer the amount of light in foot candles at all the places in the living room, kitchen and scullery where the housewife works. This and other objective data was compared with the housewife's opinion about the efficiency of her lighting and valuable information was obtained which could be used in the designing of future homes. In this survey it was found that in the main working positions of the kitchen the majority of housewives had less than one foot candle of light available to them as they worked at the sink, at the cooker or on the scullery table. This may be compared with the Illuminating Engineering Society's recommendation of 6-10 foot candles. This survey also presented an interesting check on the reliability of subjective opinions; for example it was found that housewives who said that they saw badly whilst reading by artificial light had an average of 3·4 foot candles available on their book, those who said they could see all right had 5 foot candles, whereas those who said they could see well had an average of 6·1 foot candles. Observations at other points showed the same tendency. It was also found that whereas about two-thirds of housewives considered they could see well whilst working in

daylight, the proportion who thought they could see well by artificial light was only about one-third.

In order to help the Department of Health for Scotland in the designing of new housing estates, towns and neighbourhoods, a survey was made to find out what kinds of houses were wanted and what situations were preferred. Information was obtained about all the interests and activities of each member of the family outside the home, how often they were visited and how far away they were from the town. The analysed results were then related to the opinions of the persons interviewed about the distances they had to travel. It was possible in this way to find out how far people were prepared to travel to work, to shop, to church, to the cinema and to many other places of interest without considering the journey inconvenient. For the first time it is now possible to describe convenience in terms of time and distance. This method of relating present experience to wishes has been used to obtain information about other relevant matters such as neighbourhood qualities, house design and gardens.

The essentials of this type of survey are relevance—that is to say, the survey must be confined to the problem under discussion and resist the temptation to investigate many related topics which are not of immediate importance—and speed—the social survey cannot proceed at the leisurely rate of the pre-war survey. (Mr. Rowntree's survey of York was started in 1935 and not published until 1941). In this respect the sampling method can produce results on simple matters of immediate importance in less than a week and major reports in 2 to 6 months, depending on the size of the inquiry.

Accuracy and reliability of the results are obtained by making certain, first of all, that the samples are representative, that the field workers understand their job and that adequate safeguards are taken not to draw unwarranted conclusions from the material. How this is done is explained below.

Methods

The method of work of the War-time Social Survey is as follows:

Any Government Department which has an administrative problem which can be solved by the social survey method can approach the research staff of the Survey and invite their co-operation.

The first step is usually a conference with those officers of the Government Department concerned in which the main lines of the problem are worked out. On the basis of this a "Pilot" inquiry is planned. In carrying out this "Pilot" inquiry the Research Officer concerned and a small group of field workers study the problem from the point of view of the people concerned—they may be farmers, or housewives, or miners, or women workers. At this stage the problem is discussed quite freely without any rigid questionnaire and observations are made according to the needs of the inquiry.

Reports are then made and the problem is reviewed in the light of the information obtained. On the basis of this a recording schedule is designed to contain the answers to a number of questions, or to receive descriptions, observations and measurements. This recording schedule is tested in order to make sure that it can be easily administered and that all its questions are relevant. If it passes these tests the final schedules are then printed.

It will be seen that up to the present the inquiry has been entirely qualitative and that the first job—the discovery of the qualities in the situation—has been accomplished.

The second job, that of finding out the frequencies of the qualities is the work of the sample inquiry.

The sample chosen is different in different inquiries and it may number from 1,500 to 8,000 cases depending on the number of variables in the problem and the amount of analysis required from the final results; thus if regional differences are expected and need to be known the sample will be much larger than an inquiry in which only a national picture is needed.

The problem of sampling is of tremendous importance, but this is possibly not always realised in social research although, of course, it is well appreciated in industry and in the natural sciences.

As a rule a random sample is chosen from the best available list of the population concerned; thus in Scotland where the problem was that of locating the houses of working class and middle class families a random sample of households was chosen from all those houses rated at under £35 a year. In an industrial inquiry a random sample of factories was chosen from a list of factories of a certain type and within the factories a random sample of workers was chosen from the pay roll.

In the case of a recently completed agricultural study a selection was made of the main areas of dairying, mixed farming and arable farming and a list of all parishes in this area—about two-thirds of England and Wales—was drawn up. From this list a random sample of 400 parishes was drawn. A second list of all the agricultural holdings of over 20 acres in these parishes was made and then a second random sample drawn, this time of 2,000 farms. It will be seen that this procedure ensured that every farm within these areas had an equal chance of being chosen and tests applied to the sample proved that it was entirely representative of the farming in these counties. Such a sample makes very heavy demands on the field workers for its completion and in this case journeys of about 35,000 miles were made to complete the inquiry—it would have been easier to have made an inquiry amongst farmers round and about the home counties, but such an inquiry would have been quite unreliable.

Although the field workers are sociologists the special demands of each inquiry make it necessary that they should be specially trained and briefed. In some cases this may only require a short conference, but in other cases it may require special preparation by study over a period of some months, but in all cases an inquiry is preceded by a conference at which its purpose is explained and the problems of administering the questionnaire settled. In difficult inquiries these conferences are often repeated during the course of the field work.

The document upon which the answers are recorded is not simply a list of questions and answers; in the main it is a schedule upon which answers may be recorded either by writing them out in full or by recording them as a series of codes. It has been found that when the qualities of any situation have been sufficiently studied it is almost always possible to group the answers to any question into a small number of groups. Where this is possible these

answers are given code numbers and printed on the form so that during the interview the answer is interpreted and expressed as a number. There is always provision, however, for answers which fall outside the code. It is found very often that although people express themselves in different ways the variation in content of answer as apart from form is much less than would at first be expected. It is not always possible in the "Pilot" inquiry to be certain of all possible answers to all questions so that very often questions are left open and this work of coding is then carried out at the end of the survey by a team who are specially trained in interpretation.

Grouping is also carried out in the case of observation and measurement of objective factors, like time, distance, amount of light, measurement of rooms, colour of walls, or whatever other objective factor may be the subject of the inquiry.

Once the data has been resolved into codes the work of handling it is enormously simplified since from then onwards it is possible to handle the material mechanically and the main processes involved are the enumeration of qualities. This is done by mechanical tabulation.

All the code numbers which have been allocated to the groups of answers and measurements correspond to numbers representing positions on a punch card. This punch card is a slip of stiff cardboard about 8 in. × 4 in. which has 80 columns of numbers printed on it and each number may be punched out by a small machine resembling a typewriter to record any code number. Each column or series of columns represents a group of answers and the appropriate answer to the case concerned is punched in the column. Once the information is transferred to cards in this way it is possible to handle it mechanically and machines are available which count, add and inter-relate the information contained on any card or group of cards. The basis of the process is that as the card passes through the machine electrical contacts are made through the holes in the card which transmit the impulses to counting devices on the machine. The work is done at very great speed; thus one type of machine can handle 100 cards a minute and another type 400 cards a minute. These machines do mechanically in a day, work which would take months to do by hand.

From the tabulations thus made the most relevant material is selected and further computations and correlations are made in order to make it possible to interpret easily the results.

This statistical data is then taken and interpreted in the light of the experience of the field workers and their reports of the inquiry and the reports of those who have had the job of interpreting the answers to questions and transforming them into codes. By these means every effort is made to ensure that the finer points are not lost in the process of compression.

The final report is usually prepared as a reference document and is then submitted to the department concerned.

It will be appreciated that such social inquiries can only be carried out with the co-operation of the public and on occasion it has been suggested that this might not be forthcoming. The experience of the War-time Social Survey over the last two years has been that of 250,000 interviews during some 80 inquiries, the proportion of cases where co-operation has not been obtained was less than one in two hundred.

Some parts of the work of the War-time Social Survey are now concerned with the problems of building and planning, both of housing and of social life after the war and it is clear that the experience gained during the war will be of great assistance in the peace, for as long as the State is concerned with the social life of the people it will need to have accurate information upon which it can work and will need also to be able to get answers to its administrative problems quickly and precisely.

The War-time Social Survey is most anxious to hear from other workers in similar fields and welcomes criticism of its work and its methods. It feels that at this stage in the development of sociological techniques there is a great need for exchange of experience and critical discussions and it welcomes other workers to visit it or to correspond with it on their problems.

MONTHLY NOTE BOOK—*cont. from p.* 229.

found in Japanese waters, but in the last two years has been obtained from the Pacific coast of America, South Africa, New Zealand and Great Britain. Natural resources have been augmented by deliberate cultivation of suitable types of weed. Cheaper grades of agar are used commercially as adhesives and for sizing paper and cloth. The higher grades are universally used as a medium for the laboratory cultivation of bacteria and fungi. For this purpose agar has the advantage, like gelatin, that solutions are liquid when hot but set to a jelly on cooling. Unlike gelatin, however, the cold agar is not liquefied by bacteria. Agar is also used as a laxative, as it absorbs and retains water and also acts as a lubricant.

Although used as food in many parts of the world, seaweeds are of unknown nutritive value. Though most widely used for this purpose in the East, different varieties of seaweed such as laver, dulse and murlins, are eaten as vegetables on the coasts of Scotland and Ireland. The hot water extract of another seaweed, known as carrageen moss, is widely used, particularly in war-time, as a substitute for gelatin. Dried and powdered seaweeds are sold in this country as "sea weed salt"; their iodine content is a valuable protection against goitre.

The commercial demand for seaweeds is now so great that there is a danger that the more accessible parts of the coast will become denuded of them. For the adequate re-stocking of these regions and the development of seaweed "farms" in suitable localities, much more information is needed about the requirements of seaweeds for healthy growth and the reasons for their present distribution. The investigation of these factors will prove a profitable and interesting field for future research.

REFERENCE:

"The Measurement of Pressure": *Journal of Scientific Instruments* 1944, March, p. 37.

The Night Sky in September

DAVID S. EVANS

The Moon.—The Moon is full at 20h. 21m. on September 2nd and new Moon is at 12h. 37m. on September 17th. The following conjunctions of the Moon with planets take place during the month:

11d. 06h. Saturn	0° 7	N.
16d. 08h. Jupiter	3°	S.
19d. 00h. Mars	5°	S.
19d. 11h. Venus	5°	S.

The conjunction with Saturn is a very close one, and south of about 25° South Latitude there is an actual occultation of Saturn by the Moon. By considering the relative positions of the sun and moon in the sky it can be shown that from most positions of observation the occultation will occur in daylight. This applies to the only large land mass, South Africa, from which the occultation will be visible. From almost any point in the South Atlantic beyond 25° South Latitude the occultation will be seen at night with the moon towards the eastern horizon.

Other conjunctions are:

10d. 02h. Venus in conjunction with Mars: Venus 0°·5 N.

23d. 16h. Mercury in conjunction with Jupiter: Mercury 0°·1 N.

The Planets: Mercury is at its greatest western elongation (18°) from the sun on the 22nd and so rises about 1h. 15m. before the sun. Venus is very bright, with a magnitude of −3·3 (nearly five times as bright as the brightest of the stars, Sirius) and at the beginning of the month is 17°·2 east of the sun and 5°·9 south of it. The fact that Venus is so far south of the sun means that in extreme northerly latitudes it actually sets before the sun and in moderate northerly latitudes at about the same time. It will therefore be seen as an evening star only from the southern hemisphere. By the end of the month Mars is too close to the sun to be visible, but may be glimpsed in the evening twilight at the beginning.

Jupiter on the other hand is too near the sun for observation at the beginning of the month but may be seen in the morning twilight at the end. Saturn is an evening star and is roughly at the mid-point of a line joining Betelgeuse and Castor. By the end of the month it is sufficiently far from the sun to be south at sunrise.

Sunrise and sunset in the latitude of Greenwich are:

1st Sept.	5h. 12m.;	18h. 47m.
15th „	5h. 34m.;	18h. 16m.
30th „	5h. 58m.;	17h. 41m.

At 04h. on September 23rd the sun passes through the First Point of Libra or Autumnal Equinox. This is one of the two points of intersection of the apparent annual path of the sun round the heavens (or ecliptic) with the celestial equator which is perpendicular to the axis of rotation of the earth. At an equinox the sun is overhead at some point on the earth's equator, and day and night would be equal if it were not for the lengthening of the daylight hours produced by the bending of the sun's rays in the atmosphere of the earth at rising and setting.

At Greenwich midnight (2 a.m. B.D.S.T.) the constellations of Pegasus and Andromeda are to be seen due south, and in the latitude of Britain at about 20° from the zenith. The Great Nebula is shown in the illustration, which is reproduced from Sir James Jeans's *The University Around Us* (C.U.P.). This is a huge system of stars of a flattened circular shape which because of its great distance appears only as a dim elongated patch visible on moonless clear nights. It is at a distance of 680,000 light years from us and is one of the nearest of the great nebulae. Its details can be seen on long exposure photographs made with large telescopes and it is believed to be similar to our own milky way although rather smaller. Our own galaxy seen from the Andromeda nebula would present a similar appearance although our sun would be too faint to be distinguished and its position would be right at the extreme edge of the denser central parts which are all that show in the photograph. We are so placed that we have an inclined view of the Andromeda nebula which is actually roughly circular in shape, the diameter being roughly 40,000 light years or 2,500 million times the distance of the earth from the sun. Recent work has shown that the nebula is actually rotating—not as a solid body but relatively slower at its outer edge than the centre—and taking about 80 million years for a complete revolution. It has also recently been shown that the stars of one edge appear redder than those of the opposite edge, which is interpreted as meaning that the former is the more distant one and is seen through part of the cloud of dust and gas which pervades the whole nebula.

The nebula can be seen in a small telescope or with field glasses, but is a disappointing sight since such instruments cannot show the object as anything more than a faint blur.

The Bookshelf

'42 to '44: A Contemporary Memoir. By H. G. Wells (Secker and Warburg, 1944; pp. 212; 2 guineas).

One cannot fail to be irritated by H. G. Wells. I mean the word "irritate" to be taken in its biological sense, for then it fits Wells's technique of studied provocation whereby he attempts to stimulate his readers into secreting, oyster-fashion, philosophical pearls of their own. That method he has used in most of his writings (much of his novel-writing excepted), and there is little doubt that by its use he has been able to influence the way of thinking of more than one generation. Many of the chapters of this present work, however, will give rise to nothing more than plain everyday irritation. The book claims to be a continuation and expansion of the author's *Experiment in Autobiography*, but I can find little in common between the two works. On the dust cover one finds a list of Wells's qualifications—his brand new D.Sc. lies in incongruous juxtaposition to his fellowship of the College of Preceptors—as though he wanted to set the scene for the appearance of his doctorate thesis in which he argues "that the integrality of the individual in the higher metazoa up to and including man is a biologically convenient delusion". I still prefer H. G. Wells to Dr. Wells, and I cannot help thinking that he may be pulling my leg when he writes in the preface to this memoir that "it has been written sedulously and it demands sedulity in the reader . . . Come with me to my base behind the battle-front if you will, but I warn you it will be a long and difficult journey". There is an air of mock seriousness about his suggestion that this collection of odds and ends is intended "for students only" (that is his explanation for restricting its publication to an esoteric edition of 2000 copies, *costing two guineas apiece*) and it seems almost as though he were taking his revenge for the lack of attention the world paid to the prophetic and oft-repeated warnings uttered in his earlier — and cheaper—books. A belief that some people are more impressed by the weight of a book, its price and the presence or absence of gilt edges than by the content may explain why Wells has reprinted here a number of newspaper articles which have lost their edge because they do not carry with them any contest of events. (Some such cynical belief may account for a remark in this book that "no literature is permanent because no language is permanent; all literature is journalism and will pass away in this changing world. Language will change, ideas will change, there are no immortal works, and I count all 'classics' dead and bores".)

In spite of some brilliant and vivid passages (for instance, the chapter entitled "The Optimism of the Uninjured") the volume reads like Wells's "retreat from reason". The luminous faith in rationality that one thought to be typical of Wells is lacking here right from the first chapter with its desperate heading of "The Irrational Behaviour of the Writer", and which makes much of the personal paradox of having invested money, built houses, made gardens, provided for children and grandchildren, "with the completest practical indifference to the ultimate doom that my intelligence realises is gathering over them". There is a good deal about the Sankey Declaration of Human Rights, which however are handed to us in a dispirited "take it or leave it" fashion. Wells writes as though he were tired of playing the part of a 20th century Rousseau. After reading this book I could not help thinking of the passage in Carlyle's *History of the French Revolution* dealing with the Contrat Social: "Hasn't Jean Jacques promulgated his new Evangel of a *Contrat Social;* explaining the whole mystery of Government, and how it is *contracted* and bargained for—to universal satisfaction? Theories of Government! Such have been, and will be; in ages of decadence. Acknowledge them in their degree; as processes of Nature, who does nothing in vain; as steps of her great process. Meanwhile, what theory is so certain as this, that all theories, were they never so earnest, painfully elaborated, are and by the very conditions of them, must be incomplete, questionable and even false?" Has Wells become morbidly introspective and depressed about his own theories of world government? One may recall Carlyle's additional comment on Rousseau's creed: "That a new young generation has exchanged the Sceptic Creed, *What shall I believe?* for passionate Faith in this Gospel according to Jean Jacques, is a further step in the business; and betokens much". It is likely that time will prove that the ears upon which Wells's utterances have fallen are not so deaf as Wells imagines them to be. But this contemporary memoir will give little help to those trying to understand the discords and harmonies of to-day.

W.E.D.

Edible Fungi. By John Ramsbottom. Colour Plates by Rose Ellenby. (King Penguin Books, 1943; pp. 35 + 16 pls. + 5 figs.; 2*s*.).

The Keeper of Botany at the British Museum (Natural History) has added, in his *Edible Fungi*, a worthy companion to his delightful *Book of Roses*, which was issued as a King Penguin book in 1939. The author has made the subject of edible fungi one specially his own, not only in speech and writing addressed to the public, but more intimately by many experiments on the table manners of the larger fungi; he speaks with authority backed by long experience.

Edible Fungi consists of three parts: a general part, a series of descriptions of the twenty species recommended for their esculent qualities, and a corresponding number of coloured illustrations. The general part includes historical and geographical data, a short account of the food value of fungi, a simple introduction to the botany of the fungi, and a number of kitchen hints which make the mouth water; but, the arrangement is not so severely orderly as this summary might suggest. The text is interesting and stimulating, and the book may well add to the ranks of the many who have been attracted to the study of fungi by the influence of Dr. Ramsbottom. As always, he has some whimsical quips in his writing; "wishful reflection" to describe the state of mind of the enthusiast who has eaten too freely, is topical and apt.

Two of the author's main conclusions may well be repeated here. One is that edible fungi are chiefly of value because they serve as savoury additions to an ordinary diet; the other is that it is good practice to learn a few species known to be worth eating, and to reject the rest. Any reader who will make the slight effort needed to use *Edible Fungi* intelligently, will have little difficulty in learning, from the descriptions and plates, the twenty species recommended by the book, and he will then be able to add interest and variety, not merely to a wartime diet, but to his food in the better times we all anticipate.

The choice of the twenty species selected for recommendation is soundly cautious, but it is likely that some who use the book will not agree wholly with the author. One trial was enough to convince me that the beef-steak fungus is hardly worth eating, and, after a number of tests, the chanterelle was judged to be a useful flavouring for soup, though not otherwise interesting: but these are matters of personal taste. The advice in *Edible Fungi*, if carefully followed, is safe. No one using the book as a guide to what may be eaten need fear accidents.

We are not well served in this country with botanical books which the ordinary man can read with pleasure and profit. *Edible Fungi*, in small compass, makes available a great mass of information to the general reader, and this in palatable form. Penguin Books Ltd., merit congratulation and deserve the most appropriate form of encouragement for their enterprise in nurturing public interest in matters which ought not to remain known only to the professional botanist.

B. Barnes

Heaviside's Operational Calculus Made Easy. By T. H. Turney (Chapman & Hall, 10*s*. 6*d*.; pp. viii+96).

Let it be said that for those who know the subject already, this is an entertaining and informative book, but one is puzzled to know at what class of readers the author is aiming. If they have to have the properties of the exponential function and the nature of division by an operator explained to them, and if they really need the appendix on the calculus, surely they will be completely fogged by the references to Fourier integrals and similar complicated matters which are introduced without further explanation. This might have been a very fine work if Dr. Turney could have decided beforehand exactly what level of mathematical attainment he was going to assume.

Far and Near

Scientific Films

A joint meeting of the Association for Scientific Photography and the Scientific Film Association was held at the Ministry of Information on 24th June, 1944, to discuss "The Construction and Presentation of Scientific Films". Papers were given by the Presidents of the two Associations and by Mr. Geoffrey Bell, the talks being illustrated by two films: "Control Room" and "Anæsthetics" (nitrous-oxide-ether anæsthesia).

Mr. Arthur Elton, the President of the Scientific Film Association, opened the meeting by introducing the work of the two Associations. He said that to achieve democratic self-government in any country it was necessary for the citizens to have a knowledge of the scientific processes which governed their lives. Both the Associations were really engaged in public education—not so much in teaching everyone how to solve differential equations, which was not of such importance, but rather in general information which would lessen the danger of the public being led away by filibusters such as those who had led away the countries of our enemies. The Scientific Film Association was actively engaged in spreading the use of the film for the dissemination of general knowledge of scientific methods and achievements, and also for training purposes. The Association for Scientific Photography, on the other hand, was concerned with the uses of photography and cinematography for scientific research purposes. There was thus a portion of the field where they overlapped, and he hoped that here the collaboration between the two Associations would continue to be as close as in the past.

Mr. Geoffrey Bell, speaking on "Shooting a Scientific Film", had chosen "Control Room", a film on Civil Defence, to illustrate his talk. This was a film which did not deal with a scientific subject but which was nevertheless a scientific film because it dealt with the subject scientifically, that is, it presented the facts accurately, objectively and concisely. Mr. Bell showed how direct photography and moving diagrams had been used together to illustrate the concrete and abstract information which had to be given in a film of this type.

Dr. J. Yule Bogue, the President of the Association for Scientific Photography, spoke on "The Production of Scientific Films for Biological and Medical Purposes". He outlined the practical points involved in preparing a first-class film of this type, whether it was privately produced or made by a professional film unit. He said that, although anything scientific implied an orderly presentation of the facts in an objective manner, unfortunately most medical and biological films were neither orderly nor objective; this was largely because those producing them did not plan sufficiently carefully, nor did they appreciate the possibilities of the film clearly enough. He then dealt in detail with all the technical points which had to be considered, from the preparation of the subject matter, through the methods of construction, the writing of the script and the photography, to the cutting, editing and final presentation.

After a break for tea the meeting reassembled for an informal discussion and questions to the speakers.

Angling with Poison

A lazy way—by the standards of the sporting angler—of catching fish is that practised by natives in several parts of the world. This depends on the use of fish poisons of plant origin, which are cast on the waters, killing the fish. The dead fish that rise to the surface are recovered and eaten, the fish poisons apparently being without ill-effects to humans. Two American chemists, A. Russell and E. A. Kaczka, have been investigating one source of fish poison, namely the Jamaica dogwood (*Ichthyomethia piscipula*), and their results are recorded in the *Journal of the American Chemical Society*, April 1944. They studied the effect of adding powdered root wood and root bark from this plant to water in which goldfish were swimming, and they found that if two grams of either material were added to 4 litres of water the fish died in a few minutes. Then they extracted the wood with water and obtained, on evaporating the extract, a dark-coloured resinous material which was very toxic to goldfish. Further extraction, with petroleum ether, yielded a white crystalline mass, which was lethal to fish at a dilution of one part in one million of water. The white substance proved to be a mixture of rotenone (the active principle of pyrethrum and certain other insecticides) and a closely related compound with the formula $C_{23}O_{20}O_7$ which they named ichthynone.

Food Yeast

Considerable interest was evoked last year by the release of information (Discovery, March 1943, p. 96) about the work being done at the Chemical Research Laboratory, Teddington, to perfect a process of manufacturing food yeast. The consequent demand for fuller information will be largely met with the appearance of a booklet, *Food Yeast : A Venture in Practical Nutrition*, published at 2s. 6d. by Colonial Food Yeast Ltd., Brook House, Park Lane, London, W.1, the Government-sponsored body set up to put into operation a project for making food yeast in large quantities in the colonies. The publication includes an interesting account by Dr. A. C. Thaysen of the researches, both at the laboratory stage and on pilot-plant scale, that formed the basis of the process now being put into large-scale operation in Jamaica.

Penicillin in Eire

Two young Dublin chemists, Dr. Oliver Roberts and Dr. Diarmuid Murphy, are producing penicillin in the Botanic Section of the College of Science. A month ago they had already obtained enough penicillin to enable them to treat 30 hospital patients suffering from septic wounds.

M.P. wants Underground Gasification Trials

Underground gasification of coal, to which some attention has been given in recent issues of Discovery, was mentioned in the recent House of Commons debate on Britain's coal resources. A former Minister of Mines, Mr. David Grenfell, made a plea for starting, or at any rate experimenting in, the technique here. As a corollary to the working of outcrop coal, he pointed out that there are certain seams of coal which are too deep to be worked by the outcrop method even if the overburden is removed by mechanical diggers, and too shallow to be mined by ordinary methods. Here, claimed Mr. Grenfell, was a fine opportunity for trying out something that had been done in Russia by gasification, *in situ*, with wonderful results. He cited the deposits at Keltie, Fifeshire, where a number of seams come very near the surface on a narrow anticlinal ridge. There was no reason at all, he said, why we might not get a better example of underground gasification than anywhere in Russia.

The critics who maintain that it is not worth making experiments in this direction in Britain were answered by Mr. Kenneth M. Chance, managing director of British Industrial Plastics, Ltd., when he delivered a Society of Chemical Industry lecture in Birmingham recently. "I am no engineer, but I am told by one who is", he said, "that there are plenty of abandoned workings in this country where ample coal remains for gasification underground. There are certainly unworked seams on which a trial could be made. The Russians have tried to gasify coal underground, and it ill becomes those who have failed to make any such attempt in this country—the very lifeblood of whose industry is coal—to criticise those who have had the courage to carry through practical trials on a great scale."

Quinine

The valuable anti-malarial drug, quinine, whose synthesis by two American chemists, R. B. Woodward and W. E. Doering, has been announced in the May Journal of the American Chemical Society, has a long and interesting history. Extracted from the bark of the cinchona tree, which grows wild on the western slopes of the Andes, it has been used as a chemotherapeutic agent for more than three centuries. It was first mentioned in 1638 when it is recorded that the Countess of Cinchona, wife of the Spanish governor of Peru, was cured of an attack of malarial fever by an infusion of the bark of the tree named after her. Knowledge of the value of the drug as a specific against malaria was spread rapidly through Europe, chiefly by the teaching of the Jesuits, and a great demand for it soon grew up. Under the name of "Jesuits' bark" large quantities were exported from South America. So valuable did it prove that in 1854 the Dutch government fitted out an expedition which took several hundred trees to Java.

There they flourished, and in the years before the present war the Dutch had almost a monopoly of the quinine trade. In 1859 the British government also sent out an expedition, and from the trees collected plantations were started in Ceylon and India. For various reasons those in Ceylon proved a failure, but in India they did well, and a small industry was founded.

The scientific history of quinine is also a long one. The remarkable properties of cinchona bark, in the treatment of malarial fevers, early attracted the attention of scientists. A crude form of the drug was isolated by Fourcroy as long ago as 1792 and was given the name "quina". Twenty years later a Spanish physician, Gomes, obtained a crystalline product which he named "cinchonino". Cinchonino eventually proved to be a mixture of the substances now known as quinine and cinchonine, which are chemically very closely related.

More recent investigations have shown that the anti-malarial properties of cinchona bark are due to four main constituents known as quinine, quinidine, cinchonine and cinchonidine. Of these, quinine is the most valuable. All four belong to the class of natural substances known as the alkaloids, which are complex compounds containing the elements carbon and nitrogen. Many alkaloids, such as strychnine, nicotine and morphine, are very poisonous, and it is a fortunate circumstance that, while very deadly to the malaria parasite, quinine in moderate doses produces few ill-effects in man. These four alkaloids fall into two pairs, of which each member bears a curious relationship to the other. The molecule of quinine consists of a complex pattern of atoms of carbon, hydrogen and nitrogen. The molecule of quinidine consists of a pattern which is identical, except that it must be regarded as a mirror-image of the quinine molecule. This is perhaps a difficult conception and it may be made clearer by the following analogy. If the molecule of quinine was regarded as a left-hand glove then the molecule of quinidine would be represented by the right-hand member of the same pair. Although built on exactly the same plan, they are not completely interchangeable. Cinchonine and cinchonidine are related in exactly the same manner. The phenomenon is known to scientists as "stereoisomerism", and is of common occurence. The importance of it is that the left-handed and right-handed members, although showing hardly any physical differences, may differ enormously in their effect on the body. In the case of the cinchona alkaloids it is found that, while all four show some activity against malaria, the left-handed members are always more active than the corresponding right-handed ones. While a few people are unusually sensitive to quinine, so much so that its use is inadvisable in their cases, they are generally not abnormally sensitive to the right-handed quinidine, which can therefore be prescribed with safety.

During the present war, when it has been necessary to maintain large armies in regions where malaria is prevalent, quinine has become of greatly increased importance. The loss of the Java supplies might well have proved a really severe blow had it not been possible to produce on a large scale the synthetic drugs, atebrin and plasmoquin, which also are specific against malaria. These, while very effective, can be manufactured only by a long series of chemical processes and consequently they are expensive. The news of the synthesis of quinine is therefore timely, but it should be remembered that this has as yet been achieved only in the laboratory, and it may be a considerable time, even years, before a commercially practicable process can be developed.

Since quinine was first produced in the pure state a century ago organic chemists have been engaged intermittently in the task of discovering its constitution and finding a method of synthesis. By 1908 they had discovered the way in which the atoms forming the quinine molecule were joined together. Since that time much work has been done in attempts to build up this complex arrangement from simpler ones, and for the past few years many chemists have been close to the goal. Without detracting from the high credit due to the two American workers, it must be realised that their contribution has been to add the final touch to the efforts of many other chemists of the past century. Such indeed is the general rule in many kinds of modern research. Results obtained in laboratories in all parts of the world are collated to give the final solution.

While quinine is active against the malaria parasite at almost all stages of its life in the blood it does not affect it in the reproductive phases which are marked by the actual bouts of fever. To be effective therefore, it must be administered some hours at least before the paroxysm of fever is to be expected. It is for this reason that quinine, to be effective, must be taken regularly in fever regions. Apart from its anti-malarial powers quinine is a valuable antipyretic, that is, a drug for reducing temperature. It does not reduce the temperature of the normal healthy body but it does very effectively bring it down to normal in many cases of fever, apart from those of malarial origin.

When it has to be used daily in considerable doses the bitter taste of quinine is objectionable. Certain simple derivatives of quinine do not possess this bitter taste, and although they are more expensive and larger doses are required to produce the same effect, they are used fairly considerably. They are marketed under various trade names such as saloquinine and aristoquinine.

Quinine, and more especially some of its related compounds, has a slight activity against bacteria. (Malaria is caused by an organism considerably larger than bacteria.) Possible uses in this respect are now being investigated and already some antiseptics of this type are on the market.

I.C.I. University Research Fellowships

THE I.C.I. have offered to provide at nine Universities in Great Britain Fellowships to be held by senior workers in certain Sciences. The scheme is announced to operate for an initial period of seven years. The Fellowships will be of the average value of £600 per annum, though the Universities will have power to determine the emolument for each particular appointment. The I.C.I. have described on broad lines the subjects in which the Fellowships are to be held, and the administration of the Scheme rests wholly with the Universities, which will select and appoint the Fellows, subject only to such conditions as to duties and tenure as the Universities themselves impose.

The purpose of the I.C.I. in instituting this scheme is to strengthen the general provision in the British Universities for scientific teaching and research. The directors of the I.C.I. believe that academic and industrial research are interdependent and complementary and that substantial advances in industry cannot be looked for without corresponding advances in academic science.

In their view it is important that the immediate objective should be the strengthening of University scientific departments in whatever way each University thinks to be best. No conditions whatever are attached by the Directors to the tenure of these Fellowships. The Fellows will be members of the University staffs and will be concerned only with the duties laid upon them by the Universities. Their primary work will lie in research. But they must also take some part in University teaching. It is intended not to relieve the Universities from the cost of maintaining any part of their normal work, but to enable them to add to what they already do.

The Universities to which this offer has been made comprise the larger metropolitan Universities and those which have a close geographical relation to the main centres of the Company's production. Twelve Fellowships have been offered to the Universities of Oxford, Cambridge and London, eight to the Universities of Glasgow, Edinburgh, Manchester, Birmingham, and Liverpool, and four to the University of Durham.

The Directors believe that a rational policy of this character, together with a wise selection of men both as regards capabilities and tenure of office, will lead to the emergence of a body of men capable of taking high academic or industrial positions, thereby advancing academic and industrial research.

Personal Notes

PROFESSOR HAROLD RAISTRICK, F.R.S., professor of biochemistry at the London School of Hygiene and Tropical Medicine, has been appointed honorary scientific adviser on penicillin production to the Ministry of Supply. Professor Raistrick, who is a leading authority on the biochemistry of mould metabolism, has been a member of the Ministry of Supply's penicillin production committee since its formation early last year.

DR. ALEXANDER THOM has been appointed to the chair of engineering science in the University of Oxford, which fell vacant when Professor Southwell became rector of the Imperial College of Science and Technology. Dr. Thom is well known for his researches in aerodynamics. During this war he has been working at the Royal Aircraft Establishment, Farnborough, where he has been in charge of new developments in the Aerodynamics Department.

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PROFESSOR JAMES NETHERWOOD SUGDEN, of the Imperial College of Science and Technology, was killed last month (July) by a flying bomb.

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THE new president of the Society of Chemical Industry is PROFESSOR E. K. RIDEAL.

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MR. H. A. SKINNER, B.A., B.Sc., D.Phil., has been appointed assistant lecturer in chemistry at the University of Manchester.

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PROFESSOR E. L. HIRST, F.R.S., has been appointed successor to Professor A. R. Todd as Sir Samuel Hall Professor of Chemistry at Manchester University. His appointment will, it is expected, take effect next January. His career began at Manchester, where he was assistant lecturer in 1923-24. The years 1924-26 he spent at Armstrong College, Newcastle, as lecturer in chemistry, and from there he went to Birmingham (1927-1935) as lecturer in organic chemistry, later becoming reader in chemistry there. His researches, mainly connected with the chemistry of carbohydrates and of vitamin C, led to his election as F.R.S. in 1934. Much of this work was done in association with Professor W. N. Haworth. At present he holds the post of Alfred Capper Pass Professor of Chemistry, University of Bristol. During the war he has undertaken work for the Ministry of Supply.

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SIR HOWARD FLOREY, F.R.S., who has had so much to do with the development of penicillin for medical purposes, is to visit Australia, his native country, where he will stay for three months at the direct invitation of the Australian Prime Minister.

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MR. R. B. PILCHER, for 50 years secretary of the Royal Institute of Chemistry, is retiring, probably in March of next year.

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PROFESSOR PETER KAPITZA has been awarded the Order of Lenin.

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THE Agricultural Improvement Council for England and Wales, set up for three years by the Ministry of Agriculture on June 12, 1941, is to be established on a permanent basis with a larger membership and widened terms of reference. Its object is to promote closer contact between the farmer and the scientist.

The members now appointed are:—Sir Donald Fergusson (chairman), Mr. Dennis Brown, Mr. T. Dalling, Professor Sir Frank Engledow, Mr. J. C. F. Fryer, Mr. A. Holness, Mr. A. R. Hurd, Mr. D. Lewis, Mr. T. Neame, Mr. C. Nevile, Mr. F. Rayns, Dr. E. J. Salisbury, Mr. F. A. Secrett, Mr. J. Turner, Professor J. A. Scott Watson.

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DR. A. H. R. BULLER, F.R.S., the eminent mycologist, died at Winnipeg on July 3 at the age of 69. Dr. Buller was professor of botany in the University of Manitoba, Winnipeg, from 1904 to 1936, and on his retirement he became professor emeritus. He was awarded the Royal Society's Royal Medal in 1937.

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Seaweed Research

IN Scotland a Seaweed Research Association has been established. Details of the new body were given at a conference of the Scottish Council on Industry, held in Edinburgh last month (July), it being stated that the research association will be supported jointly by the Ministry of Supply, the Development Commissioners, and many commercial and other bodies. It plans a two-year survey of the entire seaweed industry, supplies and properties, so that at the end of that period it will be possible to decide if a large seaweed industry can be started. There are to be three lines of development. One will cover the survey and classification, assessment, and location of sea weeds, littoral and sub-littoral. The engineering division will operate the *Prospecto*, a ship specially equipped and designed to gather deep seaweeds, acquired from the Ministry of Supply. It will also operate the pressing, drying, and milling of seaweed. The chemistry division will investigate the seasonal organic and inorganic constituents, and advise those who market seaweed for use as animal feeding stuffs or fertilisers, the extraction of chemicals, or the use for any other purpose of seaweed.

All three sections will be co-ordinated by the appointment of a competent director. The board is being guided in its programme by leading scientists in the country, and has been promised the full use of the facilities of other scientific organisations.

As indicated in this month's Note Book, several commercial products are already obtained from seaweeds.

Agricultural Education

The Minister of Agriculture and Fisheries and the President of the Board of Education have jointly appointed a permanent committee to advise them on all aspects of agricultural education to be provided by local education authorities, and particularly on the educational policy and methods of training to be adopted at farm institutes. The committee's terms of reference cover education up to and including Farm Institute level. Chairman of this committee is Dr. Thomas Loveday, vice-chancellor of Bristol University. To consider the problems of higher agricultural education in England and Wales, another committee has been appointed by the Minister of Education. Dr. Loveday presides over this higher education committee, which includes Dr. Charles Crowther (Principal of Harper Adams Agricultural College), Sir Frank Engledow (Professor of Agriculture at Cambridge, and a member of the Agricultural Research Council), and Professor E. J. Salisbury (Director of Royal Botanic Gardens, Kew).

Buses Run on Methane Gas

METHANE gas produced at the Stockholm sewage plant is being used to propel a number of the city's buses. Daily production of methane from this one source is said to be equivalent to about 2000 litres of petrol.

This news gains added interest when coupled with an item from the latest report of the Gas Research Board, which states that, for several years past, research workers under the direction of Sir Alfred Egerton at the Imperial College of Science and Technology have been experimenting to find the best way to separate methane from mixed gases, as for instance the mixtures found in coal mines. Liquefaction provides one effective method. It is also recorded that tests have been made using the methane so derived as a substitute fuel for driving a motor bus.

The late Dr. Marett

ROBERT RANULPH MARETT (1866-1943), Rector of Exeter College, Oxford, and an outstanding figure among British social anthropologists of the present century, is commemorated in a memorial communication to the British Academy (Oxford University Press, pp. 16, 2*s*. net), by Professor H. J. Rose of St. Andrews, a friend and former pupil. Marett, a native of Jersey and an Exhibitioner of Balliol College, Oxford, was elected a Fellow of Exeter in 1891, the year after he had begun to collect material for his essay on "The Ethics of Savage Races" for which he was awarded the Green Moral Philosophy Prize in 1893. Although Marett's college duties as Tutor lay in the field of philosophy, a subject in which he was a sound and stimulating teacher, his main personal interest throughout his life continued to be anthropology; it was in this subject that he made his greatest and most enduring contributions to philosophic and scientific thought. This he did both directly and indirectly. His formulation of the preanimistic concept in the development of primitive religion has had a profound effect in international studies on comparative religion since its first enunciation in 1899; while his activities in introducing and promoting anthropological studies in his university—he was the first secretary of the Committee of Anthropology and held that office for twenty years, have earned him a permanent place in the annals of academic and scientific advancement.

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Aspects of an Industry

"WELL AND TRULY LAID"

WITH these words His Worship the Mayor sets the seal of civic approval on the foundations of the new building. Today the foundations are as important as ever, but what manner of building will arise on them? The British building industry faces a situation in which the huge problem of the Future crowds up behind the manifold problems of the Present. The opportunity is unparalleled. Fortunately science has greatly increased the number and variety of methods and materials to enable this opportunity to be seized. Building is a field in which British research has always been prominent. It was largely through the investigation of three Englishmen — Smeaton, the constructor of the Eddystone Lighthouse, Parker and Aspdin — between 1756 and 1830 that cement was added to wood and stone and brick as a building material. During the past 50 years, developments in Portland cement, together with the increased use of steel, have transformed the technique of construction and led to the rise of a whole new industry of synthetic building materials, special cements, plastics, plasters, building boards, baseboards and insulating boards, partitions and nailing blocks, and new types of paints. The characteristics common to these materials are first that they combine strength with light weight, and secondly that they give scope alike for standardisation of design and decoration; but each has its own property or properties. One, for example, may be designed to deaden sound. Another to resist damp. A third to give protection against fire. The chemist has enabled the architect and the builder to shake themselves free of time-worn limitations. He has given them the tools with which to repair the damages of war Today, and to set about the far greater task of reconstruction Tomorrow.

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